Federal Aviation Administration – Regulations and Policies
Aviation Rulemaking Advisory Committee

Transport Airplane and Engine Issue Area
Airworthiness Assurance Working Group

Task 5 – 14 CFR/JAR 25 Aging Aircraft

Task Assignment

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

Aviation Rulemaking Advisory Committee; Transport Airplane and Engine Issues—New Task

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice of a new task assignment for the Aviation Rulemaking Advisory Committee (ARAC).

SUMMARY: Notice is given of a new task assigned to and accepted by the Aviation Rulemaking Advisory Committee (ARAC). This notice informs the public of the activities of ARAC.

FOR FURTHER INFORMATION CONTACT: Stewart R. Miller, Manager, Transport Standards Staff, ANM–110, FAA, Transport Airplane Directorate, Aircraft Certification Service, 1601 Lind Ave. SW., Renton, WA 98055–4056, telephone (425) 227–2190, fax (425) 227–1320.

SUPPLEMENTARY INFORMATION:

Background

The FAA has established an Aviation Rulemaking Advisory Committee to provide advice and recommendations to the FA Administrator, through the Associate Administrator for Regulation and Certification, on the full range of the FAA's rulemaking activities with respect to aviation-related issues. This includes obtaining advice and recommendations of the FAA's commitment to harmonize its Federal Aviation Regulations (FAR) and practices with the aviation authorities in Europe and Canada.

One area ARAC deals with is Transport Airplane and Engine Issues. These issues involve the airworthiness standard for transport category airplanes in 14 CFR part 25, 33, and 35 and parallel provisions in 14 CFR parts 121 and 135. The corresponding European airworthiness standards for transport category airplanes are contained in Joint Aviation Requirements (JAR)–25, JAR–E and JAR–P, respectively. The corresponding Canadian Standards are contained in Chapters 525, 533 and 535 respectively.

The Task

This notice is to inform the public that the FAA has asked ARAC to provide advice and recommendation on the following harmonization task:

FAR/JAR 25 Aging Aircraft

1. ARAC is tasked to review the capability of analytical methods and their validation; related research work; relevant full-scale and component fatigue test data; and tear down inspection reports, including fractographic analysis, relative to the detection of widespread fatigue damage (WFD). Since aircraft in the fleet provide important data for determining where and when WFD is occurring in the structure, ARAC will review fractographic data from representative "fleet leader" airplanes. Where sufficient relevant data for certain airplane models does not currently exist, ARAC will recommend how to obtain sufficient data from representative airplanes to determine the extent of WFD in the fleet. The review should take into account the Airworthiness Assurance Harmonization Working Group report "Structural Fatigue Evaluation for Aging Aircraft" dated October 14, 1993, and extend its applicability to all transport category airplanes having a maximum gross weight greater than 75,000 pounds.

2. ARAC will produce time standards for the initiation and completion of model specific programs (relative to the airplane's design service goal) to predict, verify and rectify widespread fatigue damage. ARAC will also recommend action that the Authorities should take if a program, for certain model airplanes, is not initiated and completed prior to those time standards. Actions that ARAC will consider include regulations to require Type Certificate holders to develop WFD programs, modification action, operational limits, and inspection requirements to assure structural integrity of the airplanes. ARAC will provide a discussion of the relative merits of each option.

This task should be completed within 18 months of tasking.

ARAC Acceptance of Task

ARAC has accepted this task and will assign it to a working group. The working group will serve as staff to ARAC to assist ARAC in the analysis of the assigned task. Working group recommendations must be reviewed and approved by ARAC. If ARAC accepts the working group's recommendations, it forwards them to the FAA as ARAC recommendations.

Working Group Activity

The working group is expected to comply with the procedures adopted by ARAC. As part of the procedures, the working group is expected to:

1. Recommend a plan for completion of the task, including rationale, for FAA/JAA approval within six months of publication of this notice.

2. Give a detailed conceptual presentation of the proposed recommendations, prior to proceeding with its work.

3. Provide a status report at each meeting of ARAC held to consider Transport Airplane and Engine Issues.

Participation in the Working Group

The working group will be composed of experts having an interest in the assigned task. A working group member need not be a representative of a member of the full committee.

An individual who has expertise in the subject matter and wishes to become a member of the working group should write to the person listed under the caption FOR FURTHER INFORMATION CONTACT expressing that desire, describing his or her interest in the task, and stating the expertise he or she would bring to the working group. The request will be reviewed by the assistant chair, the assistant executive director, and the working group chair, and the individual will be advised whether or not the request can be accommodated.

The Secretary of Transportation has determined that the formation and use of ARAC are necessary and in the public interest in connection with the performance of duties imposed on the FAA by law.

Meetings of ARAC will be open to the public, except as authorized by section 10(d) of the Federal Advisory Committee Act. Meetings of the working group will not be open to the public, except to the extent that individuals with an interest and expertise are selected to participate. No public announcement of working group meetings will be made.

Issued in Washington, DC, on August 21, 1997.

Joseph A. Hawkins,

Executive Director, Aviation Rulemaking Advisory Committee.

[FR Doc. 97–22922 Filed 8–27–97; 8:45 am]

BILLING CODE 4910–13–M

Recommendation Letter

400 Main Street
East Hartford, Connecticut 06108

Pratt & Whitney
A United Technologies Company

July 28, 1999

Department of Transportation
Federal Aviation Administration
800 Independence Ave.
Washington, DC 20591

Attn: Mr. Tom McSweeny, Associate Administrator for Regulation and Certification

Reference: ARAC Tasking FAR / JAR 25 Aging Aircraft, Federal Register (page 62 FR 45690 No. 167), dated August 28, 1997

Dear Tom:

The Transport Airplane and Engine Issues Group is pleased to submit the final report, "Recommendations for Regulatory Action To Prevent Widespread Fatigue Damage in the Commercial Airplane Fleet", Revision A, dated June 29, 1999. This report was completed by the Airworthiness Assurance Working Group and approved by TAEIG as an ARAC recommendation in response to the reference tasking statement.

Please feel free to contact us if needed.

Sincerely,

Craig R. Bolt

Craig R. Bolt
Assistant Chair, ARAC TAEIG
Boltcr@pweh.com
(Ph: 860-565-9348/Fax: 860-557-2277)

CRB/amr

cc: (letter only)

D. Baker – FAA-NWR
J. Casciano – FAA-ARM
B. Courtney – FAA-ARM
A. Hoggard – Boeing
K. Larson – FAA-NWR

Recommendation

TABLE OF CONTENTS

LIST OF ABBREVIATIONS

The following abbreviations are used throughout this report

AATF	Airworthiness Assurance Task Force
AAWG	Airworthiness Assurance Working Group
AC	Advisory Circular (FAR)
ACJ	Advisory Circular (JAR)
AD	Airworthiness Directive
AECMA	Association des Entreprises de Construction M canique et Aeronautique
AIA	Aerospace Industries Association of America
ALI	Airworthiness Limitation Instructions
ARAC	Aviation Rulemaking Advisory Committee
ART	Authorities Review Team
ATA	Air Transport Association of America
CAA-UK	Civil Aviation Authority - United Kingdom
CTOA	Crack Tip Opening Angle
DGAC	Direction G n rale de l Aviation Civile
DSG	Design Service Goal
EIFS	Equivalent Initial Flaw Size
ESG	Extended Service Goal
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
GARTEUR	Group for Aeronautical Research and Technology in Europe
HMV	Heavy Maintenance Visit
IATA	International Air Transport Association
ICWFD	Industry Committee on Widespread Fatigue Damage
JAA	Joint Aviation Authorities
JAR	Joint Aviation Requirement
MED	Multiple Element Damage
MSD	Multiple Site Damage
NAARP	National Aging Aircraft Research Program
NDI	Non Destructive Inspection
NP	None Planned at this time
NPRM	Notice of Proposed Rulemaking
NTSB	National Transportation Safety Board
OEM	Original Equipment Manufacturer
PMI	Principal Maintenance Inspector (FAA)
POD	Probability of Detection
RS	Residual Strength
SAETG	Structural Audit Evaluation Task Group
SB	Service Bulletin
SDR	Service Difficulty Report (FAA)
SFAR	Special Federal Aviation Regulation
SIA	Structural Integrity Audit
SIF	Stress Intensity Factors
SMAAC	Structural Maintenance of Aging Aircraft
SSIP	Supplemental Structural Inspection Program
STC	Supplemental Type Certificate
STG	Structures Task Group
TAEIG	Transport Airplane and Engines Issues Group
TARC	Technical Advisory Regulatory Committee
TC	Type Certification
TOGAA	Technical Oversight Group RE: Aging Aircraft
WFD	Widespread Fatigue Damage

REFERENCES

[1] NTSB Report No. NTSB/AAR - 89/03, RE: 1988 Aloha Airlines 737 Accident.

[2] A Report of the AATF on Fatigue Testing and/or Teardown Issues, February 1991, Available from the ATA.

[3] Ronald Wickens *et.al,* Structural Fatigue Evaluation for Aging Airplanes , final report of the Airworthiness Assurance Working Group, page 43-24 (October 1993)

[4] Anon., *Continuing structural integrity program for large transport category airplanes*, FAA Advisory Circular No. 91-56A, Federal Aviation Administration, U.S. Department of Transport (April 1998)

[5] Anon., Equipment, systems and installations , Federal Aviation Regulations Part 25 - Airworthiness Standards: Transport Category Airplanes, Change 10, Section 25.1309, Federal Aviation Administration, Department of Transportation, Washington D.C. (March 1997)

[6] Anon., Equipment, systems and installations , Joint Aviation Requirements JAR-25 - Large Aeroplanes, Change 14, Paragraph JAR 25.1309, Section (b), Joint Aviation Authorities, Hoofddorp, The Netherlands (May 1994)

[7] Anon., Engines , Federal Aviation Regulations Part 25 - Airworthiness Standards: Transport Category Airplanes, Change 12, Section 25.903, Federal Aviation Administration, Department of Transportation, Washington D.C. (March1998)

[8] Anon., Turbine engine installations , Joint Aviation Requirements JAR-25 - Large Aeroplanes, Change 14, Paragraph JAR 25.903, Section (d), Joint Aviation Authorities, Hoofddorp, The Netherlands (May 1994)

[9] Anon., Damage-tolerance and fatigue evaluation of structure , Federal Aviation Regulations Part 25 - Airworthiness Standards: Transport Category Airplanes, Change 11, Section 25.571, Federal Aviation Administration, Department of Transportation, Washington D.C. (August 1997)

[10] Anon., Damage-tolerance and fatigue evaluation of structure , Joint Aviation Requirements JAR-25 - Large Aeroplanes, Change 14, Paragraph JAR 25.571, Section (e), Joint Aviation Authorities, Hoofddorp, The Netherlands (May 1994)

[11] Anon., Design considerations for minimizing hazards caused by uncontained turbine engine and auxiliary power unit rotor failure , Advisory Circular No. 20-128A, Federal Aviation Administration, Department of Transportation, Washington D.C. (March 1997)

REVISION PAGE

LTR	DATE	CHANGE	PAGES ADDED	PAGES DELETED	PAGES CHANGED	APPROVED BY
-	3-11-99	Initial Release	-	-	-	-

REVISION PAGE

LTR	DATE	CHANGE	PAGES ADDED	PAGES DELETED	PAGES CHANGED	APPROVED BY
-	3-11-99	Initial Release	-	-	-	-
A	6-29-99	TAEIG Requested Change	0	0	1, 2, 10, 128	AWH

1.0 EXECUTIVE SUMMARY

In August 1997, the FAA and JAA issued a Tasking Statement through the Aviation Rulemaking Advisory Committee (ARAC). This Tasking Statement requesting that a non-advocate group be formed to examine whether or not rule-making should be initiated that would require audits of airplane structure to preclude the occurrence of widespread fatigue damage in the commercial airplane fleet. This report represents the work product of that Tasking Statement.

The Tasking was assigned to the Airworthiness Assurance Working Group (AAWG) in September 1997. This report is the culmination of 18 months of effort. In the process of the work, several conclusions and recommendations were reached. These results are presented below.

1.1 CONCLUSIONS

- With respect to the 1993 AAWG Report entitled Structural Fatigue Evaluation for Aging Airplanes
    - That the conclusions and recommendations of the 1993 AAWG Report are still generally applicable.
    - That AC 91-56A, released in April 1998 by the FAA has many inconsistencies in use of terminology and should be corrected.
    - That the list of structure susceptible to MSD/MED from the 1993 AAWG Report has been validated and expanded to include additional examples from industry experience.
    - That interaction of discrete source damage and MSD/MED need not be considered as assessment of total risk is within acceptable limits.
    - That because of the instances of MSD/MED in the fleet and the continued reliance on surveillance types of inspections to discover such damage, rules and advisory material should be developed that would provide specific programs to preclude WFD in the fleet.
- With respect to maintenance programs:
    - That an effective aging airplane program including a Mandatory Modification Program, Corrosion Prevention and Control Program, Repair Assessment Program, and a structural supplemental inspection program (SSID or ALI) is a necessary prerequisite for an effective program for MSD/MED.
    - That as long as there is an effective corrosion prevention and control program, interaction of MSD/MED with environmental degradation is minimized.

- That the use of a Monitoring Period for the management of potential multiple site damage and multiple element damage (MSD/MED) scenarios in the fleet is possible if MSD/MED cracking is detectable before the structure loses its required residual strength.
- That any program established to correct MSD or MED in the fleet needs careful consideration for the necessary lead times to develop resources to implement fleet action.

- That there is no universally acceptable or required damage size used for certification compliance.

- With respect to research programs:

    - That additional research into the residual strength behavior of structure with MSD/MED should be conducted to supplement existing database.
    - That the highest potential to achieve the necessary improvements of flaw detectability is seen in the field of semi-automated eddy current systems.

- With respect to the Fleet Health and MSD:

    - That every pre-amendment 45 commercial jet type airplane has had instances of MSD/MED in either test or service.
    - That normal inspections (e.g. maintenance programs plus aging airplane programs) conducted by the airlines using procedures developed by the manufacturer have found numerous instances of MSD/MED in the fleet since 1988.
    - That the value of SDRs in determining the health of the fleet with respect to MSD/MED occurrence is limited.

- With respect to Analytical Assessment of MSD/MED:

    - Sufficient technology exists to complete the audit in a conservative manner.
    - That most OEMs have voluntary WFD audit programs in progress.
    - That damage scenarios involving combinations of MSD and MED must be considered if there is a possibility of interaction.
    - That the AAWG participating manufacturers have developed different but viable means of calculating the necessary parameters to characterize MSD/MED and define appropriate maintenance actions whether it be a monitoring period or structure modification/replacement.
    - That the analysis procedures used to characterize MSD/MED scenarios on airplanes needs careful correlation with test and service evidence.

1.2 RECOMMENDATIONS

The following recommendations are made as a result of this study:

- That the FAA review and make changes to AC 91-56A as delineated in section 4.2.1 and 4.2.2 of this report. These changes are intended to remove ambiguous use of terminology and provide additional guidance for entities performing the structural Audit
- That the FAA fund research detailed in Section 6.0, In addition:
  - Every effort should be made to make data from tests conducted in all research programs available at the earliest possible time before formal reports are issued.
  - Tests currently funded, involving lead crack link-up, should be accomplished as soon as possible to support the first round of audits due in three years.
- That the FAA issue a subsequent tasking to ARAC to develop necessary new and/or revised certification and operational rules with advisory material to make mandatory audit requirements for MSD/MED for all transport category airplanes. This recommendation includes the development of rules and advisory material as detailed in Section 10.0.
  - Existing Transport Category Airplanes - A FAA 121 (New) Rule and/or Part 39 (Amended)
  - New Certification Programs
    - FAA 25.1529 rule revision
    - FAA 121 (New) Rule for Operator Compliance
  - FAA AC for Both 121 (New) and 25.1529 (Revised) Rule
- That WFD audits for nearly all pre-amendment 45 commercial jet airplanes should be completed and OEM documents published by December 31, 2001, with some exceptions. On other commercial jet transports, audits should be completed before the high time airplane reaches their respective design service goals.
- That a SSIP or equivalent program and Repair Assessment Program for Post Amendment 45/Pre Amendment 54 airplane be developed and implemented.
- That any rule published as a result of the subsequent tasking become effective one year after final rule publication.
- That the analysis of STCs to primary structure be held to the same audit requirements (criteria and schedule) as OEM Structure.

2.0 AVIATION RULEMAKING ADVISORY COMMITTEE TASKING

On August 28, 1997, the FAA formally notified the Aviation Rulemaking Advisory Committee; Transport Airplane and Engines Group through the Federal Register (Page 62 FR 45690 No. 167 08/28/97) of a new task assignment for action. The complete text of the Tasking Statement appears in Appendix A. Subsequently, the Transport Airplane and Engines Issues Group assigned action to the Airworthiness Assurance Working Group. The Task Assignment involves completion of the following tasks.

Task Title: ANM-97-434-A - Task 5: FAR/JAR 25, Aging Aircraft

Task Description:

(1) ARAC is tasked to review the capability of analytical methods and their validation; related research work; relevant full-scale and component fatigue test data; and tear down inspection reports, including fractographic analysis, relative to the detection of widespread fatigue damage (WFD). Since airplanes in the fleet provide important data for determining where and when WFD is occurring in the structure, ARAC will review fractographic data from representative fleet leader airplanes. Where sufficient relevant data for certain airplane models does not exist, ARAC will recommend how to obtain sufficient data from representative airplanes to determine the extent of WFD in the fleet. The review should take into account the Airworthiness Assurance Harmonization Working Group report Structural Fatigue Evaluation for Aging Aircraft dated October 14, 1993, and extend its applicability to all transport category airplanes having a maximum gross weight greater than 75,000 pounds.

(2) ARAC will produce time standards for the initiation and completion of model specific programs (relative to the airplane s design service goal) to predict, verify and rectify widespread fatigue damage. ARAC will also recommend action that the Authorities should take if a program, for certain model airplanes, is not initiated and completed prior to those time standards. Actions that ARAC will consider include regulations to require Type Certificate holders to develop WFD programs, modification action, operational limits, and inspection requirements to assure structural integrity of the airplanes. ARAC will provide a discussion of the relative merits of each option.

This task should be completed within 18 months of tasking.

As a result of the completion of the tasking, the FAA expects a task report detailing the investigations conducted along with recommendations for further FAA Action. While the recommendations may include a requirement to develop regulatory action, the actual writing of that requirement will be reserved to the FAA or assigned as an additional ARAC Tasking.

This report comprises the recommendations from the AAWG on the task assignment from ARAC. The Working Group Activity Reports presented to ARAC by the AAWG documenting the progress in completing the task are contained in Appendix B.

3.0 AIRWORTHINESS ASSURANCE WORKING GROUP

The AAWG is a duly constituted Federal Advisory Committee Act (FACA) entity. The AAWG reports to the Aviation Rulemaking Advisory Committee, Transport Airplane and Engine Issues Group (ARAC TAEIG). The AAWG was formed shortly after the 1988 Accident in Hawaii involving an older Boeing 737 in which a large section of fuselage departed the airplane. The AAWG has been active ever since examining the health of the fleet and proposing additional programs to maintain overall integrity of the commercial fleet. The membership of the AAWG consists of representation from:

Airbus Industrie*
Airline Pilot s Association
American Airlines
American West Airlines
Boeing Commercial Airplanes*
British Aerospace Airbus*
British Airways
Continental Airlines*
Delta Air Lines Incorporated*
DHL Airways Incorporated
Evergreen International Airlines
Federal Aviation Administration*
Federal Express*
Fokker Service
International Air Transport
Joint Airworthiness Authorities*
Lockheed Martin*
Northwest Airlines
Regional Airline Association
United Airlines
United Parcel Service
US Airways

The AAWG established a task group to prepare and finalize the recommendations from this Tasking. The entities identified by an asterisk, together with Daimler-Chrysler and Aerospatiale participated in the task group. In completing the Task, the AAWG met eleven times in the 18-month period. A list of meeting venues and meeting attendance is documented in Appendices C and D respectively.

4.0 BACKGROUND

In 1988, the industry experienced a significant failure of the airworthiness system. This system failure allowed an airplane to fly with significant unrepaired multiple site fatigue damage to the point where the airplane experienced a rapid fracture and loss of a portion of the fuselage. As a direct result of this accident, the FAA hosted The International Conference on Aging Airplanes on June 1-3, 1988 in Washington D. C. As a result of this conference, an organization of Operators, Manufacturers and Regulators was formed under the Federal Advisory Committee Act to investigate and propose solutions to the problems evidenced as a result of the accident. This group is now known as the Airworthiness Assurance Working Group (AAWG) (Formally know as the Airworthiness Assurance Task Force).

During the 1988 conference, several Airline/Manufacturer recommendations were presented to address the apparent short falls in the airworthiness system including Recommendation 3, which stated:

> "Continue to pursue the concept of teardown of the oldest airline aircraft to determine structural condition, and conduct fatigue tests of older airplanes per attached proposal."

In June 1989, the National Transportation Safety Board (NTSB) made Recommendation 89067 (Reference[1]) that requested the FAA to pursue necessary tasks to ensure continued safe operations with probable widespread fatigue damage (WFD). WFD was noted by the NTSB to be a contributing cause of the April 1988 Aloha Airlines 737 accident. The NTSB specifically recommended extended fatigue testing for older airplanes. In November 1989, the FAA responded by issuing a straw man SFAR RE: TWO-LIFE TIME FATIGUE TEST FOR OLDER AIRPLANES.

In June 1990, the AAWG tasked the formal evaluation of the AIA/ATA Recommendation 3. An alternative approach, Reference [2,3], to the straw man SFAR was developed by the AAWG and presented to the FAA in March 1991. The FAA accepted this alternative approach in June 1991. The AAWG was informally tasked to institutionalize the position in July.

The AAWG task objective was:

> The AAWG shall make recommendations on whether new or revised requirements for structural fatigue evaluation can and should be instituted as an airplane ages past its design service goal. These recommendations are limited to the A300 (Models B2, B4-100, B4-200, C4 and F4), BAC1-11, 707/720, 727, 737 (Models 100 and 200), 747 (Models 100 and 200), DC-8, DC-9, DC-10, F-28 and L-1011 airplanes.

In December 1992, the task was formally published in the Federal Register as an Aviation Rulemaking Advisory Committee (ARAC) task directed to the AAWG from the Transport Aircraft and Engine Issues Group (TAEIG). The task assigned was:

> Task 3 - Structural Fatigue Audit: Develop recommendations on whether new or revised requirements for structural fatigue evaluation and corrective action should be instituted and made mandatory as the airplane ages past its original design life goal.

In accomplishing the task, the AAWG assembled a subset of the working group to reach industry consensus. Industry participation in the task group included members from ATA, IATA, AIA, AECMA, FAA and JAA. In October of 1993, the AAWG formally presented their recommendations, Reference [3] to ARAC concerning Task 3. In general, those recommendations included a proposal for revising existing guidance material and that voluntary audits be conducted for the eleven AAWG models.

4.1 AFFIRMATION 1993 ARAC RECOMMENDATIONS

In 1993, ARAC made seven recommendations to the FAA and JAA concerning a structural audit for widespread fatigue damage. Those recommendations were:

4.1.1 1993 ARAC Recommendations

1. That the AAWG promote a WFD evaluation of each AAWG model within the existing STG environment, using the guidance of AC 91-56 as modified under Recommendation Number 2. These evaluations should be conducted in the timeliest possible fashion relative to the airplane model age.

2. That AC 91-56 be modified to include guidelines for WFD evaluation by the addition of Appendix 3 as shown in the 1993 AAWG Report, Reference [3].

3. That the STGs recommend appropriate fleet actions, through the SSIP or service bulletin modification programs.

4. That the AAWG be made responsible to monitor evaluation progress and results for consistency of approach for all models.

5. That mandatory action should enforce STG recommendations by normal FAA/JAA means.

6. That additional rule making is not necessary or desirable for timely achievement of the evaluation safety goals for the 11 AAWG Models.

7. That additional actions for airplanes currently in production should only be considered after completion of the initial evaluations of the 11 AAWG models.

The basic recommendation was to amend CAA Airworthiness Note 89 and FAA AC 91-56 to include guidance for a proposed structural audit for widespread fatigue damage (ARAC Recommendations 1 and 2). Furthermore, the report advocated that the audit would be performed voluntarily by the Structures Task Groups (STGs) under the direction of the manufacturers with any safety related issues being mandated by the regulators (ARAC Recommendation 3 and 5).

4.1.2 1999 Adjustments to the 1993 Recommendations

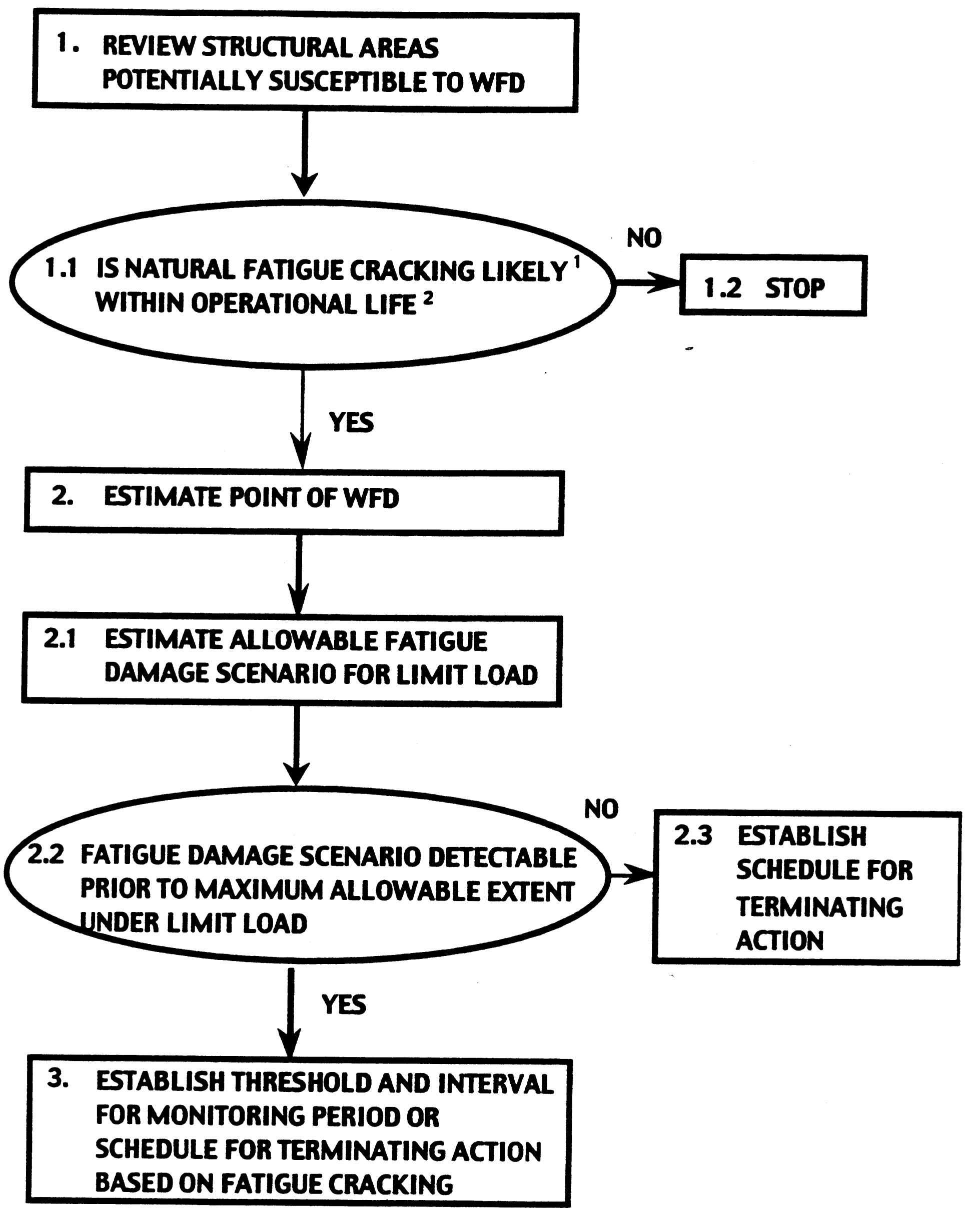
Six years have passed since these recommendations were made. A final copy of AC 91-56A was issued in April 1998 that goes well beyond the 1993 recommendations, being applicable to all large transport category airplanes (ARAC Recommendation 7). Beyond this one point, the 1993 recommendations are still generally valid as long as specific goals are being attained in the voluntary manufacturer audits. This report specifically looks at individual model requirements for the audits covering all large transport airplanes and the progress to complete those audits. Courses of action for the regulators to follow should a manufacturer not complete the audit are also examined (ARAC Recommendation 6).

The AAWG also looked on the recommendations made in the 1993 report in three specific areas. The first was with respect to the areas susceptible to MSD/MED. In reviewing these areas, the AAWG identified four additional design details that have a tendency to develop MSD/MED; these areas have been added to the complete compendium of details contained in Section 5.2 of this report.

Secondly, the AAWG examined Figure 1 of the 1993 Report, Reference [3], and proposed several changes to the Figure based on how an analysis would actually be performed. In addition the AAWG has now removed the requirement for the joint consideration of rotor burst and the presence of MSD/MED in the structure. The latter of these changes are discussed in detail in Section 5.3 of this report. The revised Figure 1 is shown in Figure 4.1.1.

Finally, the subject of monitoring period has been revisited with the purpose of defining with greater detail the circumstances and the limits with which this particular approach could be used. This is further discussed in Section 4.4 of this report.

AIRPLANE EVALUATION PROCESS – STEP 1

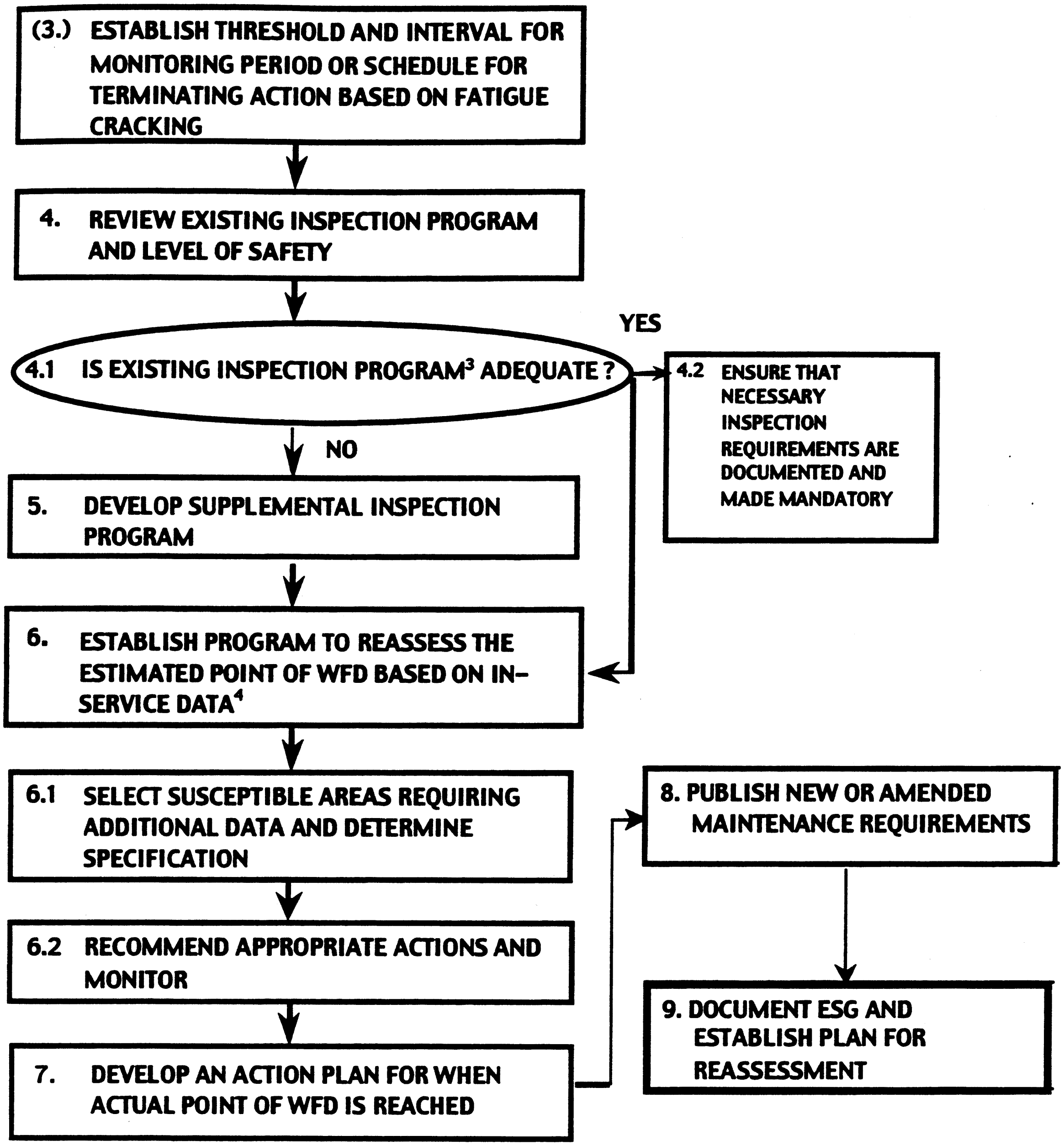


NOTES:

1. **Fatigue cracking is defined as likely if the factored fatigue life is less than the projected ESG of the airplane at time of WFD evaluation.**
2. **The operational life is the projected ESG of the airplane at time of WFD evaluation.**

Figure 4.1.1 Airplane Evaluation Process

AIRPLANE EVALUATION PROCESS – STEP 2



Notes:

3. Inspection threshold, inspection intervals and inspection methods must be adequate to detect single or multiple cracking.
4. The evaluation process must be repeated if the operational life is increased

Figure 4.1.1 Airplane Evaluation Process - Continued

4.2 ADVISORY CIRCULAR 91-56A

In 1993, the second ARAC Recommendation to the FAA and JAA, Reference [3], proposed a modification to Advisory Circular 91-56, to include guidelines for a structural audit for Widespread Fatigue Damage. These guidelines were to be based on proposals contained within the 1993 Industry Committee report. A draft issue of the amended Advisory Circular, known as AC 91-56A, was issued in June 1997, and the AAWG subsequently undertook a review of the guidance material contained within this document. In addition, comments were solicited from ATA/AIA members.

In general, the AAWG concurred with the intent of AC 91-56A. The Advisory Circular implements many of the ARAC recommendations from 1993, although a number of general points may be noted, as follows:

- The scope of the Advisory Circular has been expanded to cover all large transport category airplanes, rather than the original 11 AAWG Models under consideration in 1993. However, this does not invalidate the 1993 Industry Committee proposals.

- The AAWG agrees with the need for OEMs to accomplish Widespread Fatigue Damage (WFD) assessment prior to operation of aging airplanes beyond DSG. However, it must be emphasised that the implementation of changes to the model-specific Supplemental Structural Inspection Program should be a joint effort by the Structures Task Group. Any service actions that require separate AD action should be processed through the ATA Airworthiness Concern Lead Airline Process.

- The AC is intended to be general in nature, and there are consequently many unknowns and hypothetical situations which would best be commented on when individual NPRMs are issued against each fleet to incorporate the WFD program.

Unfortunately, the draft AC was found to contain many inconsistencies, especially in dealing with terminology, and the AAWG made a number of specific recommendations to the FAA for revisions to the text. The majority of these suggestions were incorporated into the first issue of AC 91-56A, Reference [4], which was released in April 1998, although some concerns raised by the AAWG were not addressed by the modified document. This section summarizes the outstanding issues arising from the AAWG review, which have been allocated to one of the following three categories:

- Suggested text changes for clarification and understanding;
- Questions regarding the interpretation of wording or phrases in the text;
- Additional comments from operators.

4.2.1 Text Changes

The following changes to the text are suggested for clarification or to aid understanding. Paragraph numbers refer to the paragraph in AC 91-56A, Reference [4].

- Paragraph 6b: the second sentence states *Since the SID is applicable to all operators and is a safety concern for older airplanes...* . Since the purpose of the SID is to detect cracks before they result in a safety concern, this should be changed to read *Since the SID is applicable to all operators and is intended to address potential safety concerns on older airplanes...* .

- Paragraph 10: states that the development of a WFD program *should be initiated no later than the time when the high-time or high-cycle airplane in the fleet reaches three quarters of its Design Service Goal* . This should be changed to include and address airplanes that have already exceeded three quarters of their Design Service Goal as recommended in this report.

- Paragraph 11: the second and third sentences state *The same would be true for WFD AD's that require special inspections. WFD AD's that require structural modification would be handled separately.* Although the intention of the industry committee on WFD was that any areas of concerns arising from a WFD evaluation would be incorporated into existing programs such as the Aging Aircraft Modification Program or the SSID, the words here indicate that specific ADs for WFD will be issued if a concern is found. This should therefore be changed to read *The same would be true should the Aging Aircraft Modification Program or the SSID, mandated by AD's, be revised to account for structural areas susceptible to WFD* .

- Appendix 1, Paragraph 4a: this paragraph refers to Appendix 1, Paragraph 2c, where the original document contained an exception which dealt with a relaxation of the limit load requirements for airplanes not certified to current/ 25.571 standards. This exception has been removed from the proposed text, and should be reinstated.

- Appendix 2, Paragraph 1c: the second sentence states *Since a few cracks of a size which may not be reliably detected by Non Destructive Testing (NDT) can cause unacceptable reduction in the structural strength below the residual strength requirements of the damage tolerance regulations...* . This should be changed to read *Since a few cracks of a size which may not be reliably detected by Non Destructive Testing (NDT) can cause unacceptable reduction in the residual strength of the structure...* .

- Appendix 2, Paragraph 1c: the last sentence states *The manufacturers should conduct evaluations...* . This should be changed to read *The manufacturers, in conjunction with the operators, should conduct evaluations...* .

- Appendix 2, Paragraph 2b (1) (c): frames are already mentioned in (a) and therefore should be deleted or left as a stand alone item in (c)

- Appendix 2, Paragraph 2c (2): states *Each susceptible area should be evaluated for a discrete source damage event due to uncontained failure of engines, fan blades, and high-energy rotating machinery*. The industry recommendation allowed a risk evaluation to determine the areas requiring a discrete source damage evaluation. This should therefore be changed to read *Each susceptible area should be evaluated for a discrete source damage event due to uncontained failure of engines, fan blades, and high-energy rotating machinery, unless it has been demonstrated that the risk due to such an event does not exceed an acceptable level*.

4.2.2 Interpretation of Text

The following comments are questions regarding the interpretation of wording, phrases or intent.

- Paragraphs 7, 8 & 9: these Paragraphs are already covered by other regulatory material such as ADs, proposed ACs, and proposed NPRMs. What is the FAA s intent in including these paragraphs here?

- Appendix 2: this Appendix replaces the previous Appendix 2, which contained a list of published SSID programs. Will a future revision to this AC contain a similar list in an Appendix 3?

- Appendix 2, Paragraph 2.b.(1)(e): states "*other pressure bulkhead attachment to skin and web attachment to stiffeners and pressure decks (MSD, MED)*". What does this mean? This issue should be examined in the context of the changes shown in Section 5.2 of this report.

- Appendix 2, Paragraph 2c: what is meant by the term "*test-to-structure factors*" in the last sentence?

- Appendix 2, Paragraph 2e: the intent of this section on period of evaluation validity requires clarification. One possible interpretation is that the initial evaluation will impose a service life on the airplane which can only be extended by additional evaluation. Also, this extended service life is only valid providing the maintenance requirements of the WFD program are met. The AAWG believes that this is the correct interpretation of the text and the FAA should make it clear in the AC Text.

4.2.3 Additional ATA/AIA Comments

Comments were also solicited by the AAWG from ATA/AIA members, in order to allow input from operators not participating in the AAWG. The concerns and queries raised by ATA/AIA members regarding AC 91-56A that were not addressed by the AAWG review were as follows:

- Our understanding of the SSIP program implementation at half design service goal (Paragraph 6, Reference [4]) and WFD inspection program implementation at three quarters design service goal (Paragraph 10, Reference [4]) is that the OEM will have a program drafted by that time. It is our understanding that airplanes will not be inspected by that time. To more clearly make the distinction between when a SSIP program needs to be drafted and when it needs to accomplished, we request the wording to Paragraph 6 more closely parallel Paragraph 10, Reference [4]. Replace "*the program should be initiated no later than the time when the high-time or high-cycle airplane in the fleet reaches one half its design service goal*", with "*development of the program should be initiated no later than the time when the high-time or high-cycle airplane in the fleet reaches one half of its design service goal*".

- We are unclear as to whether or not the WFD inspection program will be applicable to all airplanes as they reach a threshold or whether the WFD will be implemented as a sampling program. Note the recommendations of this report advocate a WFD inspection program applicable to all airplanes above a threshold. No sampling programs are allowed.

- The development of new NDI techniques and procedures is a critical part of the WFD program, and is possibly the weak link. More R&D is needed in the NDI area to provide reliable inspection methods required to detect "small cracks" (on the order of .020 inches) necessary for WFD control. Since this is presently beyond NDI large area capability, we anticipate that once MSD/MED is identified in any structure, extensive modification will be required prior to further operation.

- We must emphasise that the success of this program is dependent upon the joint efforts of the OEMs and operators. We advocate and encourage greater interchange of the technical data generated by the OEMs in compliance with this Advisory Circular. This should be an added explicit requirement contained within the Advisory Circular, *i.e.* a forum should be established for the dissemination of such data to the operators.

4.3 DEFINITIONS

An important aspect of the problem of aging airplanes is the terminology used in discussing the subject. The definitions for certain criteria and their relationships can radically change the concepts of widespread fatigue damage and continuing structural integrity.

Following the Aloha Airlines accident of 1988, the FAA initiated rulemaking to revise FAR 25.571 in order to address shortcomings found as a result of the accident investigation. These revisions dealt specifically with the addition of a requirement for fatigue test evidence for new certifications to address the possibility of widespread fatigue damage. The FAA was assisted in this process by an AIA TARC committee (TC 218-3) and Technical Oversight Group RE: Aging Aircraft (TOGAA). Appropriate changes to the regulations were proposed in 1992, and were published as NPRM 93-9, which included a number of definitions of criteria pertaining to widespread fatigue damage.

In a separate regulatory activity under the auspices of the ARAC, a working group of the TAEIG submitted a revision of AC 91-56 that addressed widespread fatigue damage in the existing fleet. This document, which was completed in 1993, represented a harmonized position accepted by the technical experts of the American and European aerospace industry, the FAA and the JAA. However, the revised AC contained a different set of definitions to those proposed in 1992 and contained in NPRM 93-9. Although the differences were of minor textual importance, the changes made to the definitions were considered technically significant. Nevertheless, the 1993 definitions remained essentially unchanged over the following five years, despite being revisited during two subsequent harmonization tasks.

As part of the initial activities of the AAWG, the established ARAC developed definitions were reviewed and found to remain clear and technically valid. This view was unanimously endorsed by the TAEIG, which recommended that NPRM 93-9 and the accompanying draft AC be changed to reflect the ARAC definitions. After some discussion, the industry position on the definitions was accepted by the FAA and published in Amendment 96 to FAR Part 25 on April 30, 1998.

The approved ARAC definitions are given immediately following this paragraph. It is urged that any future publications on the subject of widespread fatigue damage should include, or at least reference this standard terminology, in order to avoid possible confusion within the industry.

<u>Damage Tolerance</u> is the attribute of the structure that permits it to retain its required residual strength without detrimental structural deformation for a period of use after the structure has sustained specific levels of fatigue, corrosion, accidental or discrete source damage.

<u>Widespread Fatigue Damage</u> (WFD) in a structure is characterized by the simultaneous presence of cracks at multiple structural details that are of sufficient size and density whereby the structure will no longer meet its damage tolerance requirement (*i.e.* to maintain its required residual strength after partial structural failure).

Multiple Site Damage (MSD) is a source of widespread fatigue damage characterized by the simultaneous presence of fatigue cracks in the same structural element (*i.e.* fatigue cracks that may coalesce with or without other damage leading to a loss of required residual strength).

Multiple Element Damage (MED) is a source of widespread fatigue damage characterized by the simultaneous presence of fatigue cracks in similar adjacent structural elements.

In addition, the AAWG proposes the adoption of the following terminology during discussion of programs to ensure continuing structural integrity:

Fatigue Crack Initiation is that point in time when a finite fatigue crack is first expected.

Point of WFD is a point reduced from the average expected behavior, i.e. lower bound, so that operation up to that point provides equivalent protection to that of a two-lifetime fatigue test.

Monitoring Period is the period of time when special inspections of the fleet are initiated due to an increased risk of MSD/MED, and ending when the point of WFD is established.

Design Service Goal (DSG) is the period of time (in flight cycles/hours) established at design and/or certification during which:

1. The principal structure will be reasonably free from significant cracking
2. Widespread fatigue damage is not expected to occur.

Extended Service Goal (ESG) is an adjustment to the design service goal established by service experience, analysis, and/or test during which:

1. The principal structure will be reasonably free from significant cracking
2. Widespread fatigue damage is not expected to occur.

Furthermore, certain terminology has been considered by past working groups in relation to the problem of WFD, but was not used in the final ARAC definitions. The following terms have been previously identified as being open to misinterpretation, and should be avoided, or defined carefully if their use is essential.

Threshold has been used in various contexts, such as

- Fatigue Threshold, which may be defined as the first typical fatigue crack in the fleet for that element .

- Inspection Threshold, which may be defined as the start of supplemental inspections for WFD . The AAWG believes that the real meaning of WFD in this context is MSD/MED.

Onset has been used as an alternative to Threshold, although the simultaneous use of both terms may cause confusion.

Sub-Critical has been used in relation to certain fatigue cracks. However, this may require clarification of what are critical fatigue cracks with reference to occurrence of WFD.

4.4 MONITORING PERIOD

The Monitoring Period is a concept that could be used in a number of situations where MSD/MED crack growth is detectable before the structure loses its required residual strength. Figure 4.4.1 is included to depict the differences between local damage crack growth and MSD/MED crack growth. This figure acknowledges the interaction and accelerated crack growth and rapidly decreasing residual strength expected in MSD/MED situations. It also indicates that while the MSD/MED crack growth and residual strength degradation occurs in a more rapid sense, it also is expected to occur later in the life of a given area of structure compared to expected cracking due to local damage. The Supplemental Inspection Program and the more recent Airworthiness Limitations Instructions were written and intended only to access the structure for local damage. Additional inspections and/or modification programs are required for MSD/MED at some point in the life of the airplane.

Figure 4.4.2 depicts how a Monitoring Period might be established for an area of structure that meets the qualification of detectable MSD/MED damage before it reaches critical length. There are several points that are essential in establishing this period. First is the establishing of the Point of WFD (a point reduced from the average expected behavior). This point, beyond which the airplane may not be operated without further evaluation, is established so that operation up to that point provides equivalent protection to that of a two-lifetime fatigue test. The determination of equivalence between test evidence and actual airplane expected life is a subject of discussion between the OEM or STC holder and the regulator. Repeat inspection intervals are established based on the length of time from detectable fatigue cracks to the average WFD (average behavior) divided by a factor. Several opportunities must be provided to detect cracking between fatigue crack initiation and the Point of WFD.

Figure 4.4.3 depicts the antithesis of the previous statement by showing an example of a situation where a Monitoring Period definitely can not be used. Where the situation in Figure 4.4.3 actually exists, the only recourse would be to modify the structure before significant cracking occurs in the fleet.

In section 7.1.3, a number of instances where MED/MSD conditions have been identified in the transport category fleet are discussed. These instances have been identified through the ongoing inspection, maintenance, and restoration activities of the operator community. These inspection, maintenance, and restoration activities have been and will continue to be invaluable in detecting MSD/MED in the fleet.

In Figure 4.4.2, the contribution to safety of these ongoing-programmed inspections has been recognized under the heading of "Normal Inspection Programs." Normal inspections include Maintenance Program, CPCP, SSID, and other mandatory and non-mandatory activities accomplished on the airplane.

While a Type Design holder and/or operator may acknowledge existing inspections and incorporate new inspections as part of the WFD audit process, no further rulemaking on the separate programs which make up the "Normal Inspection Programs" should be required or mandated.

There are a number of general conditions and details that must be met in order that a monitoring period concept can be used. These conditions are:

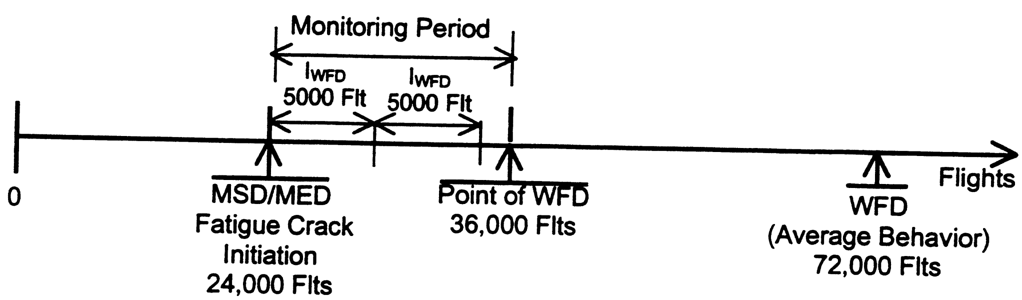
- No airplane may be operated beyond the defined Point of WFD without modification or part replacement.
- The first special inspections, to occur in the monitoring period, should be in line with the estimation of fatigue crack initiation.
- To use a monitoring period for a detail suspected of developing MSD/MED, it must be determined that inspections will reliably detect a crack before the crack becomes critical. If a crack cannot be reliably detected, a monitoring period cannot be used.
- By empirical analysis, evaluation of test evidence and/or evaluation of in-service data, the inspection requirements will be defined for application during the monitoring period.
- The purpose of these inspections is to collect data for reassessment of WFD parameters and to maintain structural integrity (e.g., acceptable level of risk during the monitoring period). Inspections within the monitoring period are mandatory on every airplane as well as reporting of inspection results.
- In the case of MSD or MED findings, the Point of WFD will be re-established in accordance to the inspection results. The area of concern will be repaired following a detailed inspection of adjacent areas using NDI technology that will detect small cracks with a high degree of confidence. The remaining airplanes may be operated up to the revised Point of WFD, with application of a revised monitoring program. Prior to the Point of WFD, the airplane must be repaired, modified, or retired.
- If no MSD/MED cracking is detected by the time the high time airplane reaches the predicted Point of WFD, the predicted Point of WFD could be re-evaluated and the special inspection program may be continued after revalidation.
- The monitoring period will terminate at the point in time at which there is sufficient findings to confirm a MSD/MED problem exists and/or the Point of

WFD is reached. This will be recommended with the assistance of the STG using an established process.

The AAWG reviewed several examples of service actions that have been developed as a result of the development of MSD/MED cracks in both service and test. The following are typical values that can be expected for monitoring periods used in fuselage type structure.

WFD (Average Behavior)	=	72,000 Flights
I_{WFD}	=	5,000 Flights
Point of WFD	=	36,000 Flights
MSD/MED Fatigue Crack Initiation	=	24,000 Flights

GRAPHICALLY THIS WOULD LOOK LIKE THIS



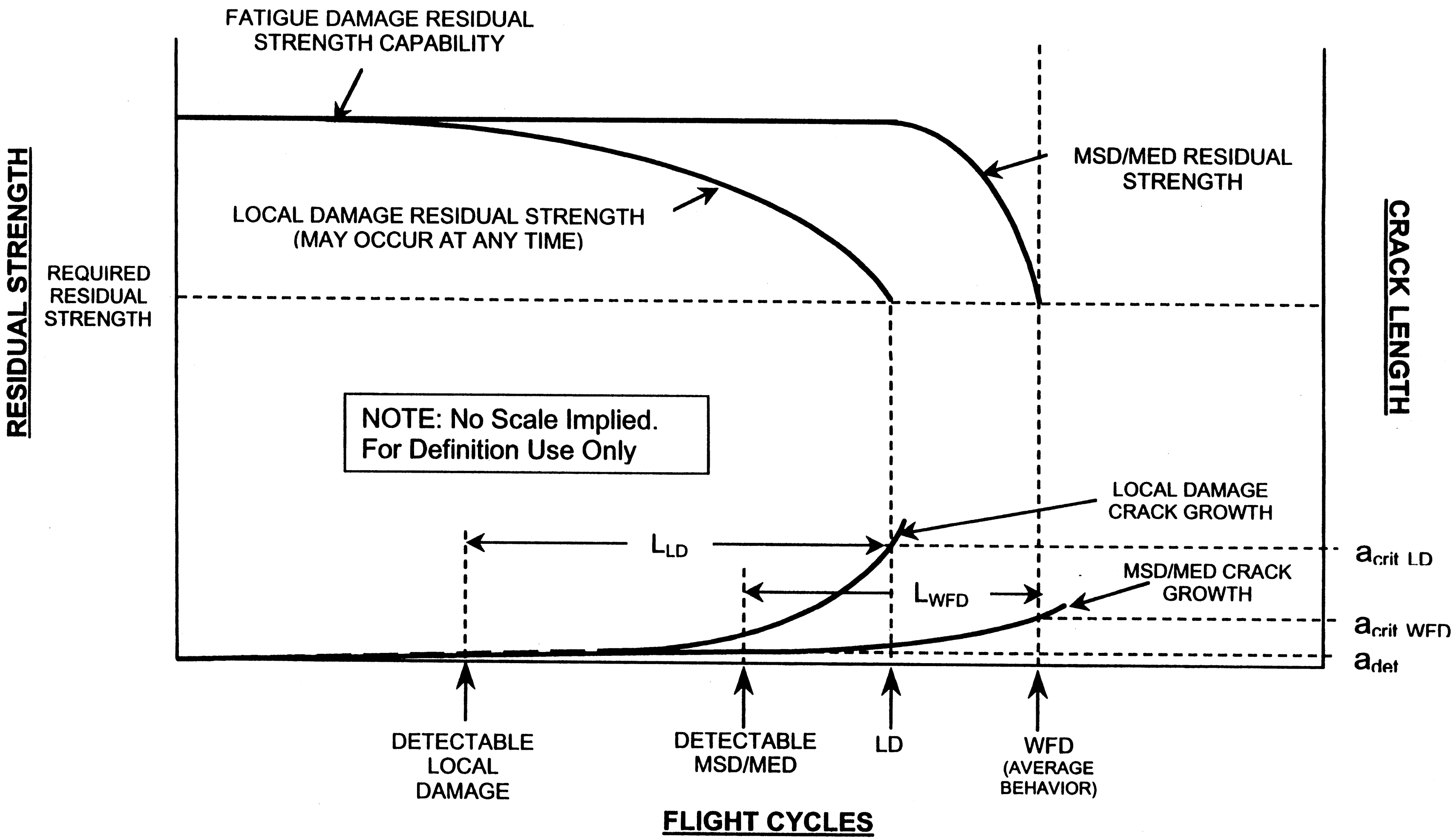


Fig. 4.4.1: Difference Between Local Damage Behavior and MSD/MED Behavior for a Typical Detail

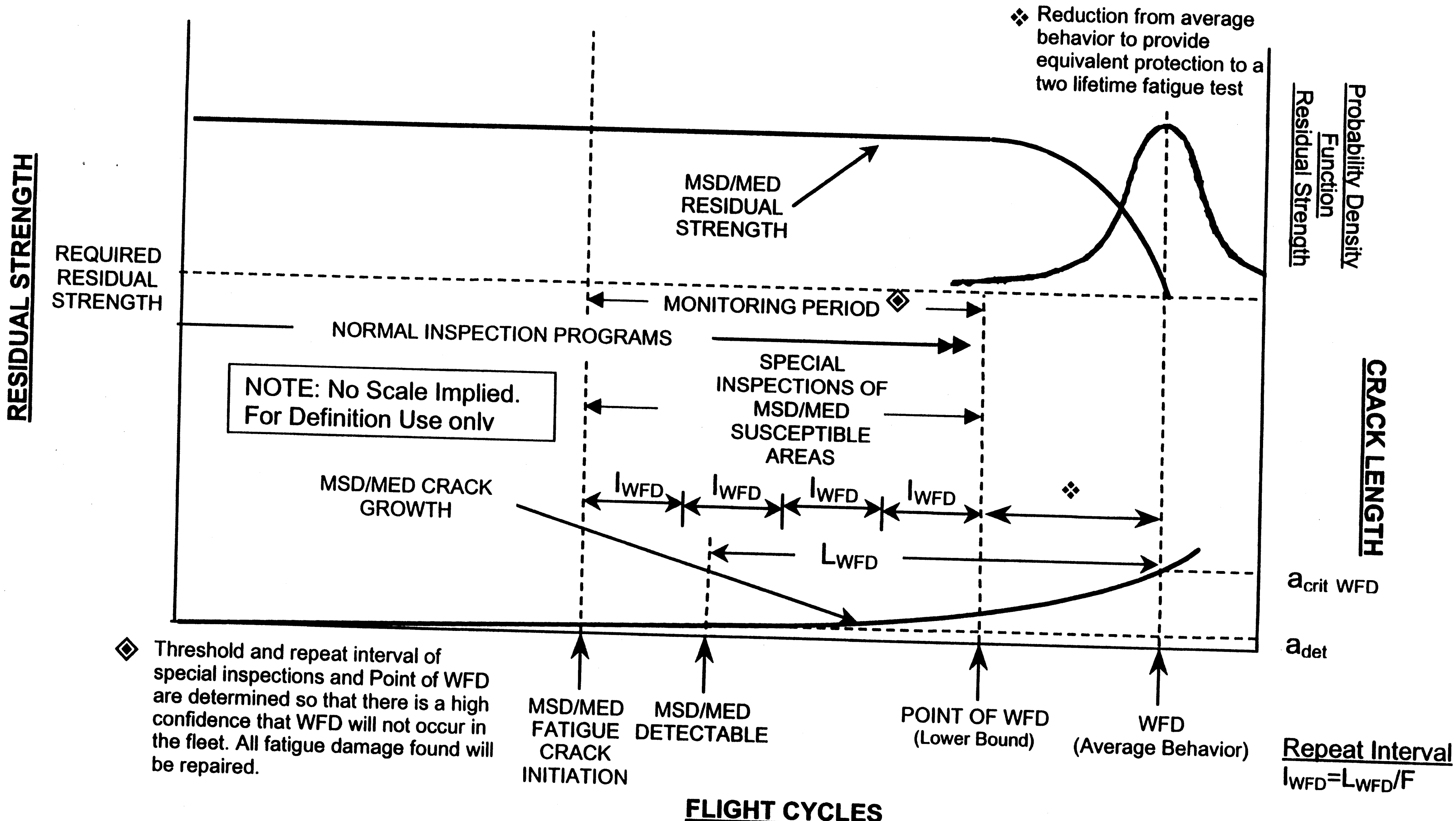


Fig. 4.4.2: Determination of the Monitoring Period for the Airplane Fleet

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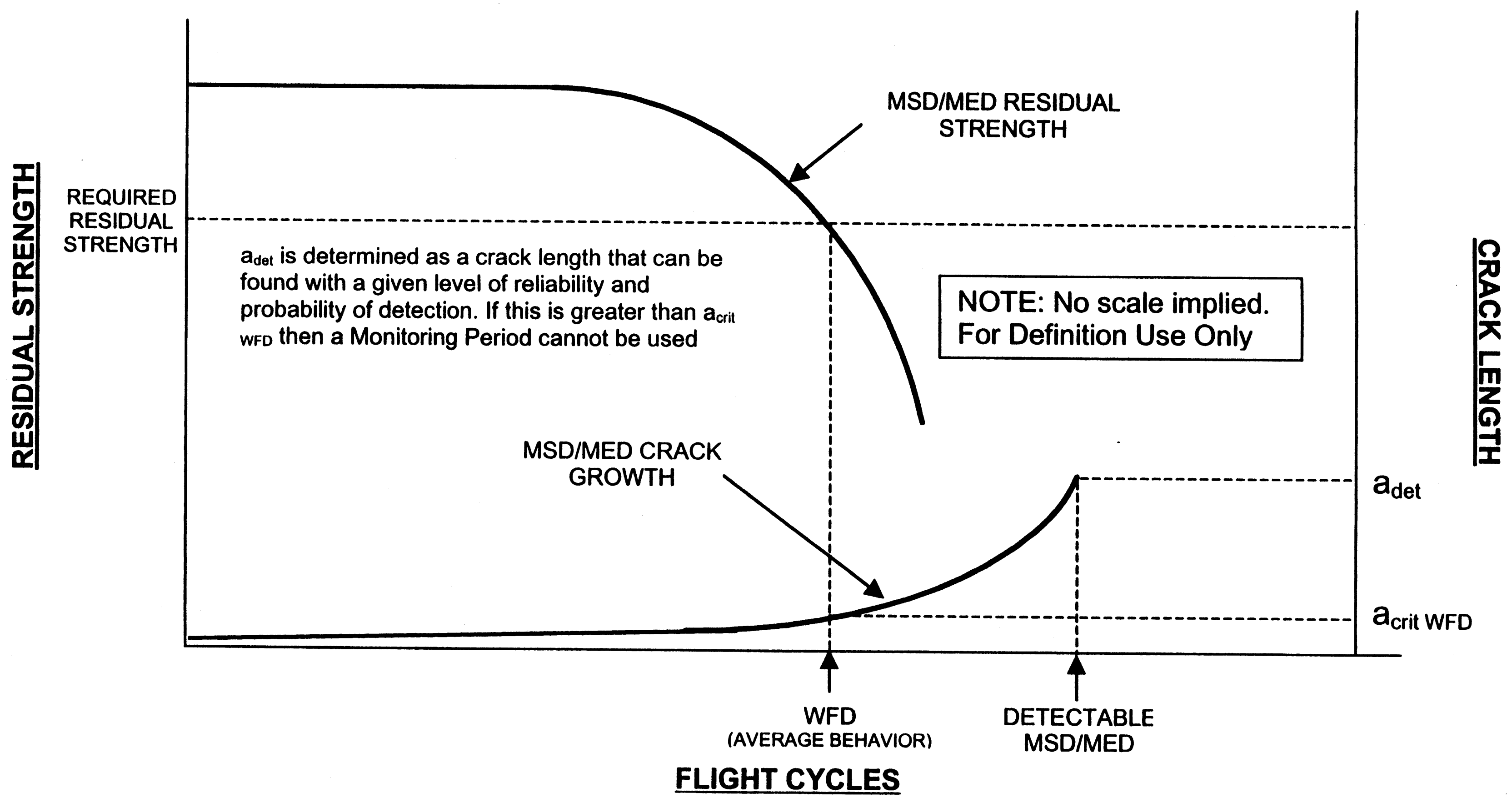


Figure 4.4.3: Condition Where Monitoring Period Cannot Be Used

4.5 PROPRIETARY DATA ISSUES

The following statement was developed by the AAWG to provide guidance to individual working group members on how Proprietary Data issues would be handled.

The AAWG, in evaluating the need for and extent of research and development for widespread fatigue damage, will be collecting data from a variety of sources including national research organizations, private research groups, and airplane manufacturers. In the process, it is not the intent of the AAWG to collect information that would constitute a breach of individual corporate proprietary data rules. Individuals representing various entities should clear, prior to submittal, all transfers of information to the AAWG with their respective officers in charge of proprietary data. Data given to the AAWG may be published, attributed to source and subject to public scrutiny.

5.0 TECHNICAL ISSUES

5.1 AUTHORITIES REVIEW TEAM ISSUES AND ACTION

The ARAC Tasking required that a team of technical experts from the regulators review the technical program, developed by the AAWG. The purpose of this review was to validate the approach adopted by the AAWG. This review occurred in the March 1998 Gatwick UK meeting. The team, hereafter known as The Authorities Review Team, or ART, consisted of:

John Bristow, Chair	CAA-UK
Bob Eastin	NRS Fatigue and Fracture, FAA
Brent Bandley	Aerospace Engineer, FAA
Stephane Boussu	DGAC - France

The ART reviewed the approach of the AAWG with respect to the tasking as well as presentations on OEM methodologies. John Bristow, chair, expressed his thanks for participation of the AAWG-TPG at the ART Review. He expressed that while there were certain things that needed to be addressed, the ART felt that the team was properly composed and heading in the right direction.

The ART did find areas within the scope of the program that they needed further development from both a regulatory and a technical viewpoint. A total of twenty issues were presented to the AAWG for resolution. The AAWG evaluated each of the issues and then assigned action to resolve each issue. The following table delineates the issues and actions that were assigned and completed.

ITEM	ISSUE	Final Report Section
1	The ART would like to see a more immediate focus on validation of OEM methodologies through round-robins etc. and a defocus of R&D review.	8.6
2	The ART would like to see more information related to residual strength testing related to WFD.	Sec 6.1.5
3	The ART would like an explanation of Objective Evidence specifically what the meaning of Qualitative vs. Quantitative is.	Explain at next review
4	The ART believes that there is sufficient data available to determine the state of the fleet WRT MSD/MED. For example, the ART wants the AAWG to review SDR data in coming to conclusions regarding the health of the fleet.	7.0
5	The ART would like to see more real-life examples.	7.0
6	The ART wants more information on STCs and how the issue might be addressed.	5.6
7	The ART does not understand the issue of Restraints in getting fleet data.	7.0

ITEM	ISSUE	Final Report Section
8	The ART would like the establishment of a baseline detectable flaw to consider in-service constraints including the requirement of wide area inspections and would like that information by the end of April 1998.	6.2
9	The ART wants more information WRT the DPD presentation on monitoring period.	4.4
10	The ART needs justification for the removal of discrete source damage.	5.3
11	The ART feels that if the existing maintenance program is adequate to detect MSD/MED, then that program should be mandated.	4.1
12	The ART will look for a recommendation on how to overcome the shortfall in technology.	6.0
13	The ART will require a consistent usage of terminology and definitions by the AAWG	4.3
14	The ART will need a significantly higher level of technical presentation at the next review.	Agreed
15	The ART desires to see on a fleet by fleet basis, timelines delineating when the analysis is complete, when the changes to the maintenance programs (e.g. mandatory mods, SSID changes etc.) will be complete, and when the programs need be implemented in the fleet.	9.0/10.0
16	The ART will require a revisit to the at risk fleets. They feel freighters need to be included, the logic behind the division at 1/2 DSG is not clear (needs to be supported by fleet evidence), and that there may be other airplanes needed in priority 2 by virtue of derivative design. They would also like to see the number of airplanes exceeding 100% DSG and the actual DSG for each Aircraft fleet.	Table 9.1
17	The ART requires additional information regarding Step 1.1 of The Airplane Evaluation Process . They would like additional definitions developed and an additional step added.	Figure 1.1
18	The ART would like to understand how allowable lead times for modifications are established.	9.2
19	The ART needs additional data WRT how life limits would be imposed and how the handling of a non-compliance action occurs.	10.0
20	While the ART concurs that the monitoring period is an appropriate means to work this problem, the developments of appropriate constraints are necessary to make the approach viable.	4.4

The Report Section numbers refer to where the issues are discussed in detail.

5.2 AREAS SUSCEPTIBLE TO MSD/MED

Susceptible structure is defined as that which has the potential to develop MSD/MED. This structure has the characteristics of similar details operating at similar stress levels where structural capability could be significantly degraded by the presence of multiple cracks.

Figures 5.1 through 5.16 illustrate major sections of airplane structure, and construction typical of those areas, which industry experience has shown to be susceptible to MSD/MED. The illustrations shown are typical and do not show all types of construction or structural details, which may be peculiar to an airplane model. Some model specific examples may be best illustrated by a combination of these examples. Additional areas of the model specific structure should be assessed if indicated by service or test experience.

MSD and/or MED can also occur in structure that does not have a major impact on the continued safe operation of an airplane. For example MSD cracking of a web adjacent to a stiffener may not be any more significant than a single fatigue crack. Also, it is not expected that secondary structure will be included in the WFD assessment.

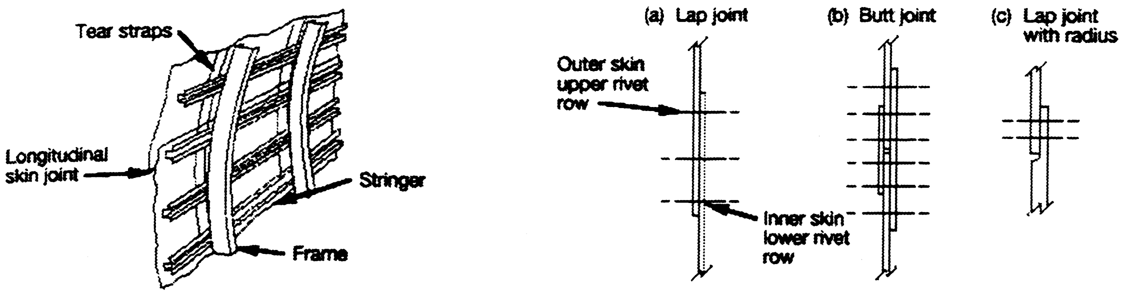
Susceptible areas are characterized by similar structural details operating at uniform stress levels. There are many significant structural problems that can occur in airplane structure due to fatigue cracking but they typically <u>are not</u> precursive forms WFD. Examples are:

- CHRONIC INSERVICE FATIGUE PROBLEMS, which left undetected or uncorrected, could lead to a significant failure.
- MULTIPLE PARALLEL CRACKS which grow parallel to each other and do not have the potential to link-up
- ELEMENTS IN COMMON such as a fuselage bulkhead (skin, web, and cap) or a wing spar (skin, cap, and web). Fatigue cracking of a single element if left undetected or uncorrected can ultimately lead to fatigue cracking of all three elements at a common location. Service actions and AD s should be adequate.
- LINK-UP OF INDEPENDENT FATIGUE PROBLEMS in adjacent but not similar structural elements (not MED) can grow, if not corrected, until they link-up resulting in a very significant loss in residual strength. STG service action review should mandate corrective action.

The priority to be assigned to each susceptible structural item to be evaluated for widespread fatigue damage will be dependent upon the individual airplane model. The OEM or STC holder should assess these properties for each airplane model on the basis of in-service experience, test and/or analysis. It is recommended that this survey be performed at the start of the evaluation.

The list of structure potentially susceptible to MSD/MED first appeared in the 1993 report of the Industry Committee on Widespread Fatigue Damage. Additional areas and details have been added as a result of further review of service experience. Additionally, details of crack locations have been clarified.

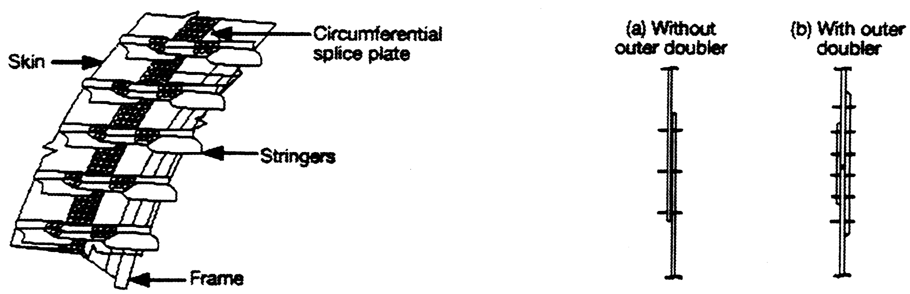
STRUCTURAL AREA	FIGURE
• Longitudinal Skin Joints, Frames, and Tear Straps (MSD/MED)	5.1
• Circumferential Joints and Stringers (MSD/MED)	5.2
• Lap joints with Milled, Chem-milled or Bonded Radius (MSD)	5.3
• Fuselage Frames (MED)	5.4
• Stringer to Frame Attachments (MED)	5.5
• Shear Clip End Fasteners on Shear Tied Fuselage Frames (MSD/MED)	5.6
• Aft Pressure Dome Outer Ring and Dome Web Splices (MSD/MED)	5.7
• Skin Splice at Aft Pressure Bulkhead (MSD)	5.8
• Abrupt Changes in Web or Skin Thickness Pressurized or Unpressurized Structure (MSD/MED)	5.9
• Window Surround Structure (MSD, MED)	5.10
• Over Wing Fuselage Attachments (MED)	5.11
• Latches and Hinges of Non-plug Doors (MSD/MED)	5.12
• Skin at Runout of Large Doubler (MSD) Fuselage, Wing or Emp	5.13
• Wing or Empennage Chordwise Splices (MSD/MED)	5.14
• Rib to Skin Attachments (MSD/MED)	5.15
• Typical Wing and Empennage Construction (MSD/MED)	5.16



Type and possible location of MSD and MED
- MSD longitudinal skin joint
  - Lap joint
    - Outer skin upper rivet row
    - Inner skin lower rivet row
  - Butt joint
    - Skin outer rivet rows
    - Doubler inner rivet rows
  - Lap joint with radius
    - In radius
- MED—frame
  - Stress concentration areas
- MED—tear straps
  - Critical fastener rows in the skin at tear strap joint

Service or test experience of factors that influence MSD and MED (examples)
- High stress—misuse of data from coupon test
- Corrosion
- Disbond
- Manufacturing defect
  - Surface preparation
  - Bond laminate too thin
  - Countersink, fastener fit
- Design defect—surface preparation process

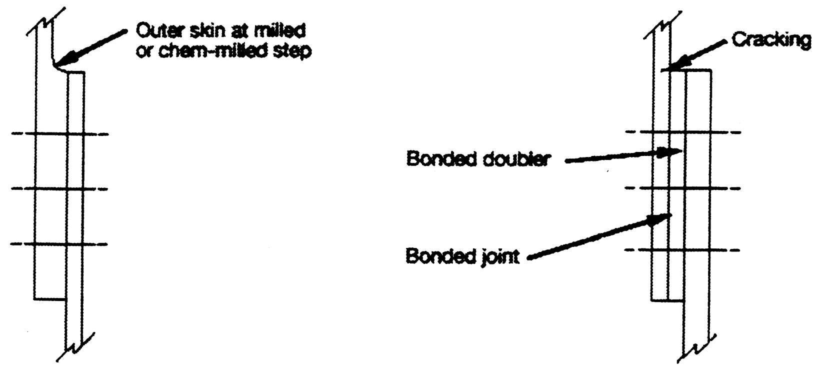
Figure 5.1 Longitudinal Skin Joints, Frames, and Tear Straps (MSD/MED)



Type and possible location of MSD/MED
- MSD—circumferential joint
  - Without outer doubler
    - Splice plate—between and/or at the inner two rivet rows
    - Skin—forward and aft rivet row of splice plate
    - Skin—at first fastener of stringer coupling
  - With outer doubler
    - Skin—outer rivet rows
    - Splice plate/outer doubler—inner rivet rows
  - MED—stringer/stringer couplings
    - Stringer—at first fastener of stringer coupling
    - Stringer coupling—in splice plate area

Service or test experience of factors that influence MSD and/or MED (examples)
- High secondary bending
- High stress level in splice plate and joining stringers (misuse of data from coupon test)
- Poor design (wrong material)
- Underdesign (over-estimation of interference fit fasteners)

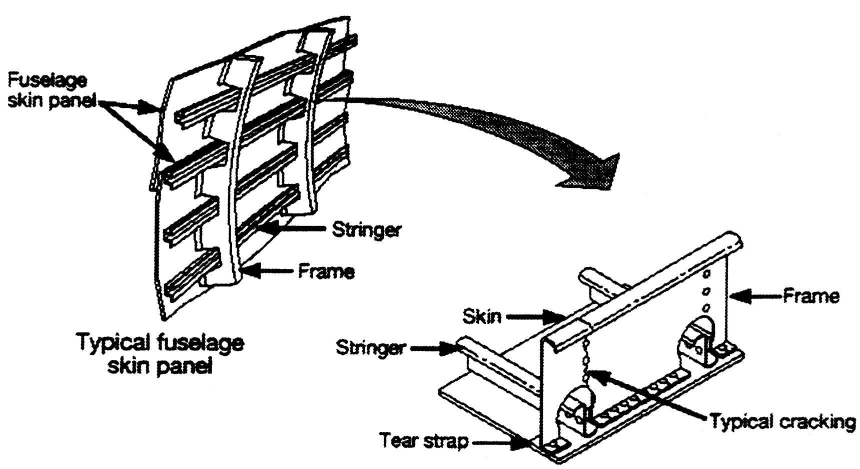
Figure 5.2 Circumferential Joints and Stringers (MSD/MED)



Type and possible location of MSD and MED
- MSD—abrupt cross section change
- Milled radius
- Chem-milled radius
- Bonded doubler runout

Service or test experience of factors that influence MSD and MED (examples)
- High bending stresses due to eccentricity

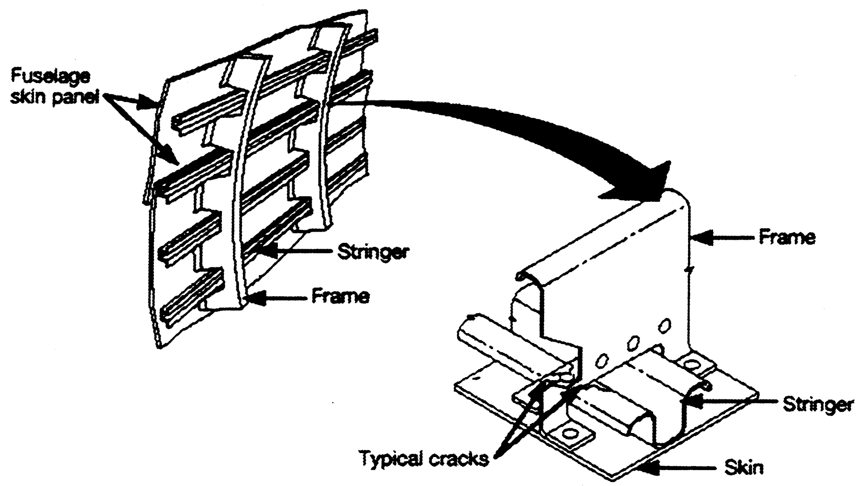
Figure 5.3 Lap joints with Milled, Chem-milled or Bonded Radius (MSD)



Type and possible location of MSD/MED
- MED—the cracking of frames at stringer cutouts at successive longitudinal locations in the fuselage. The primary concern is for those areas where noncircular frames exist in the fuselage structure. Fractures in those areas would result in panel instability.

Service or test experience of factors that influence MSD and/or MED (examples)
- High bending—noncircular frames
- Local stress concentrations
  - Cutouts
  - Shear attachments

Figure 5.4 Fuselage Frames (MED)



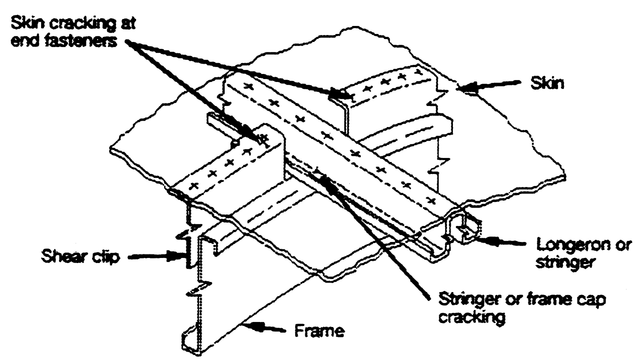
Type and possible location of MED

- MED—any combination of fracture of frames, clips, or stringers, including the attachments, resulting in the loss of the shear tie between the frame and stringer. This condition may occur at either circumferential or longitudinal locations at fuselage frame/stringer intersection.

Service or test experience of factors that influence MSD and/or MED (examples)

- Poor load path connection

Figure 5.5 Stringer to Frame Attachments (MED)



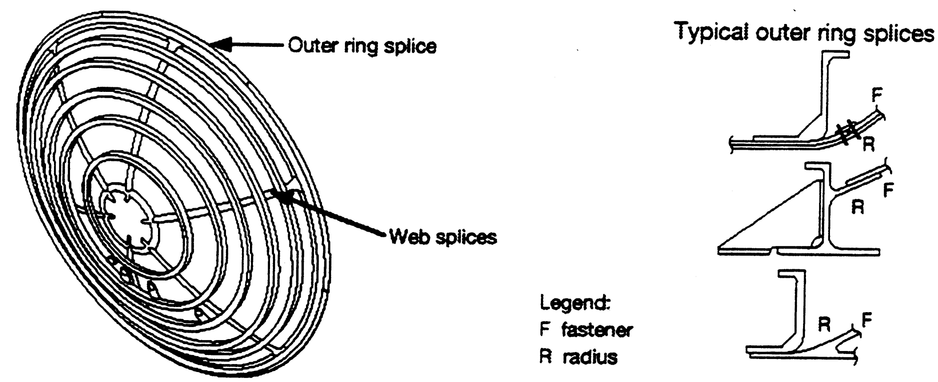
Type and possible location of MSD and MED

- MSD—skin at end fastener of shear clip
- MED—cracking in stringer or longeron at frame attachment
- MED—cracking in frame at stringer or longeron attachment

Service or test experience of factors that influence MSD and MED (examples)

- Preload
- Localized bending due to pressure
- Discontinuous load path

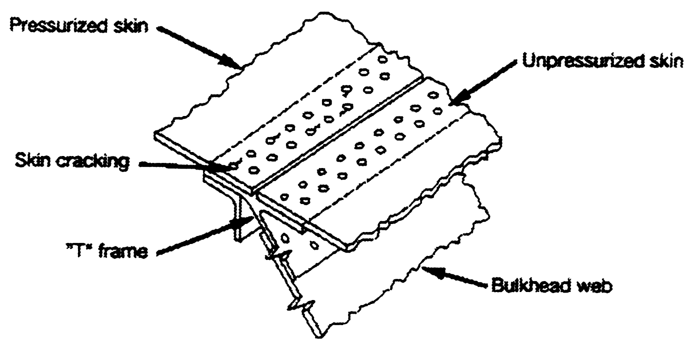
Figure 5.6 Shear Clip End Fasteners on Shear Tied Fuselage Frame (MSD/MED)



Type and possible location of MSD/MED
- MSD/MED—outer ring splice
  - Attachment profiles—at fastener rows and/or in radius area
- MED—web splices
  - Bulkhead skin and/or splice plates—at critical fastener rows

Service or test experience of factors that influence MSD and/or MED (examples)
- Corrosion
- High stresses—combined tension and compression
- High induced bending in radius
- Inadequate finish in radius—surface roughness

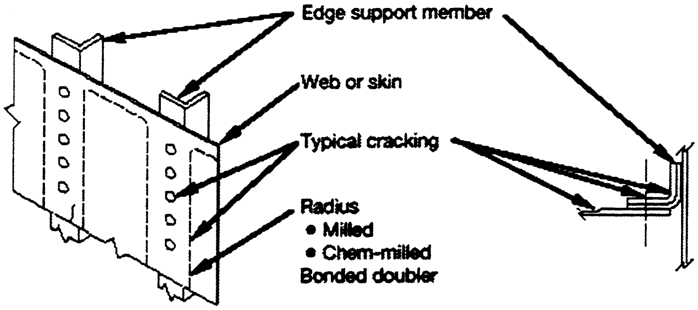
Figure 5.7 Aft Pressure Dome Outer Ring and Dome Web Splices (MSD/MED)



Type and possible location of MSD and MED
- MSD—skin at end fastener holes

Service or test experience of factors that influence MSD and MED (examples)
- Shell discontinuous induced bending stresses
- High load transfer at fastener

Figure 5.8 Skin Splice at Aft Pressure Bulkhead (MSD)



Type and possible location of MSD and MED

Abrupt change in stiffness*
- Milled radius
- Chem-milled radius
- Bonded doubler
- Fastener row at edge support members

Edge member support structure
- Edge member - in radius areas

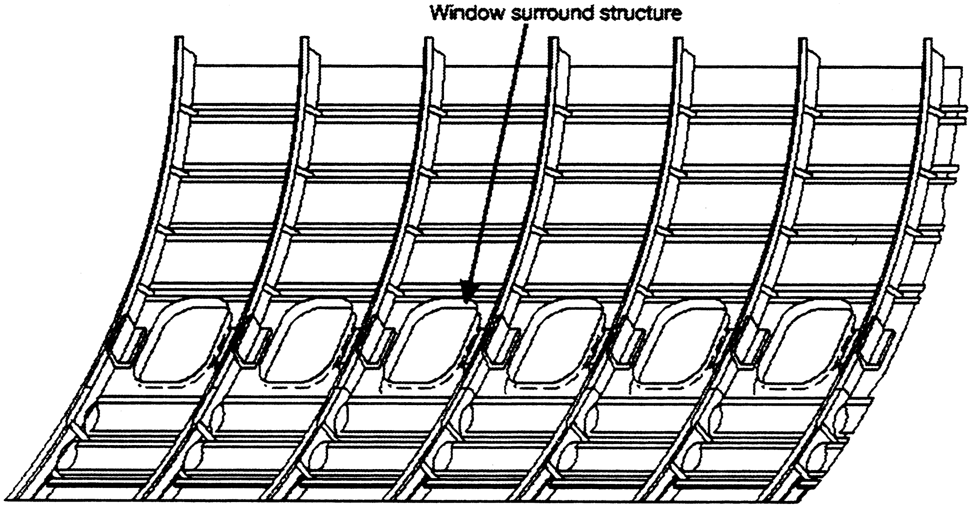
Service or test experience of factors that influence MSD and MED

Pressure structure
- High bending stresses at edge support due to pressure

Non-pressure structure
- Structural deflections cause high stresses at edge supports

* Often multiple origins along edge member

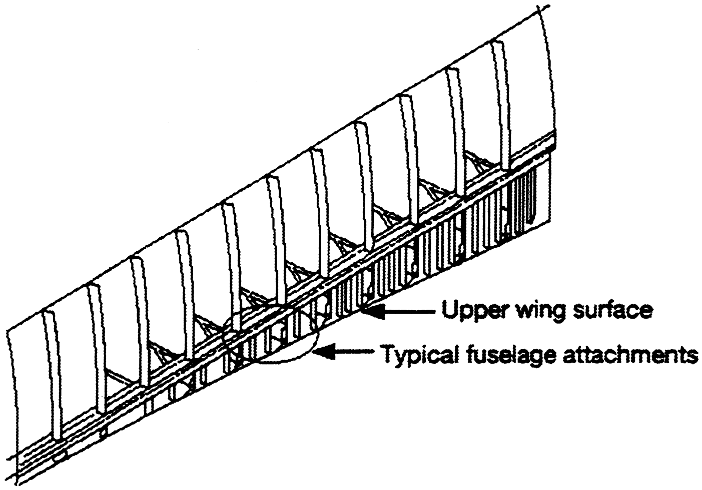
Figure 5.9 Abrupt Changes in Web or Skin Thickness Pressurized or Unpressurized Structure (MSD/MED)



Type and possible location of MSD/MED
- MSD—skin at attachment to window surround structure
- MED—repeated details in reinforcement of window cutouts or in window corners

Service or test experience of factors that influence MSD and/or MED (examples)
- High load transfer

Figure 5.10 Window Surround Structure (MSD, MED)



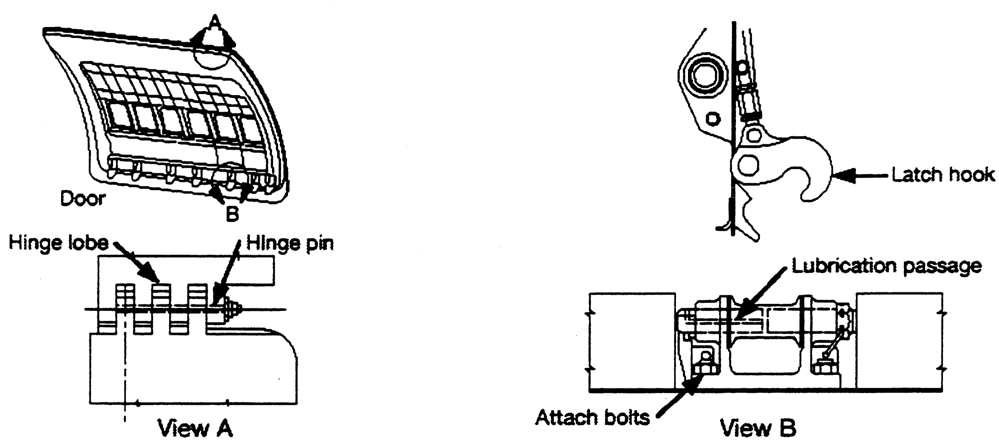
Type and possible location of MSD/MED

- MED—repeated details in overwing fuselage attachments

Service or test experience of factors that influence MSD and/or MED (examples)

- Manufacturing defect—prestress
- Induced deflections

Figure 5.11 Over Wing Fuselage Attachments (MED)



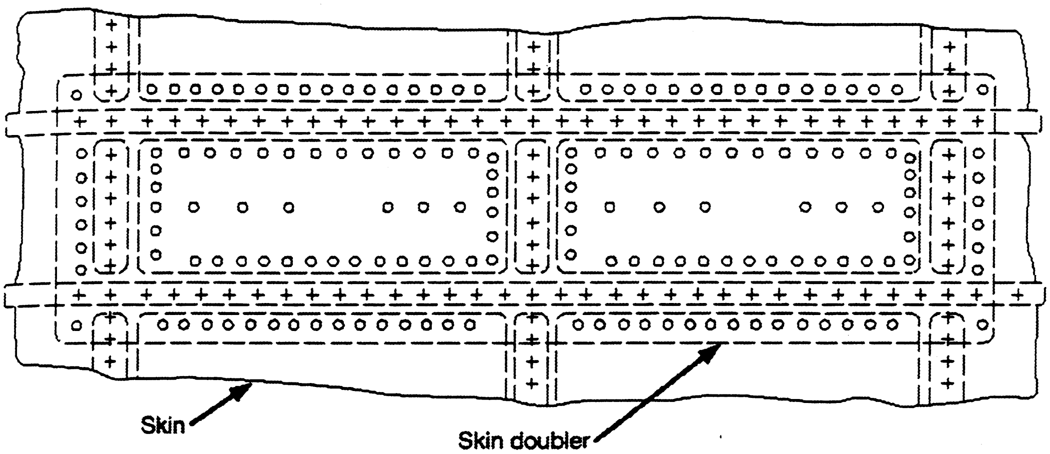
Type and possible location of MSD/MED

- MSD—piano hinge
  - At hinge fastener attachment row
  - In fillet radius
  - Emanating from hole in lobes
- MED—latches
  - In multiple latch hooks
  - At lube channel of latch spool
  - At spool bracket attach bolts (also corrosion)

Service or test experience of factors that influence MSD and/or MED (examples)

- Bending stresses due to fuselage elongation
- High local stress
- Fretting

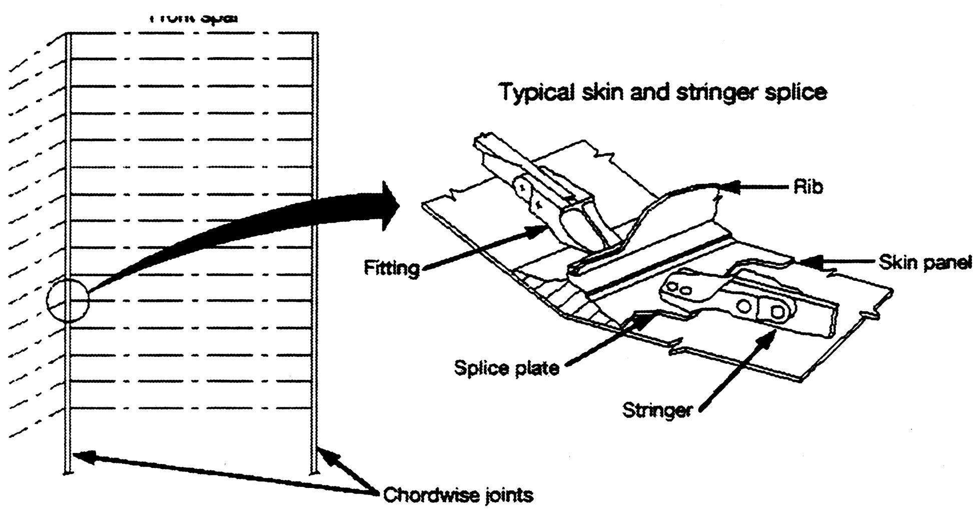
Figure 5.12 Latches and Hinges of Non-plug Doors (MSD/MED)



Type and possible location of MSD/MED
- MSD—cracks initiated at multiple critical fastener holes in skin at runout of doubler

Service or test experience of factors that influence MSD and/or MED (examples)
- High load transfer—high local stress

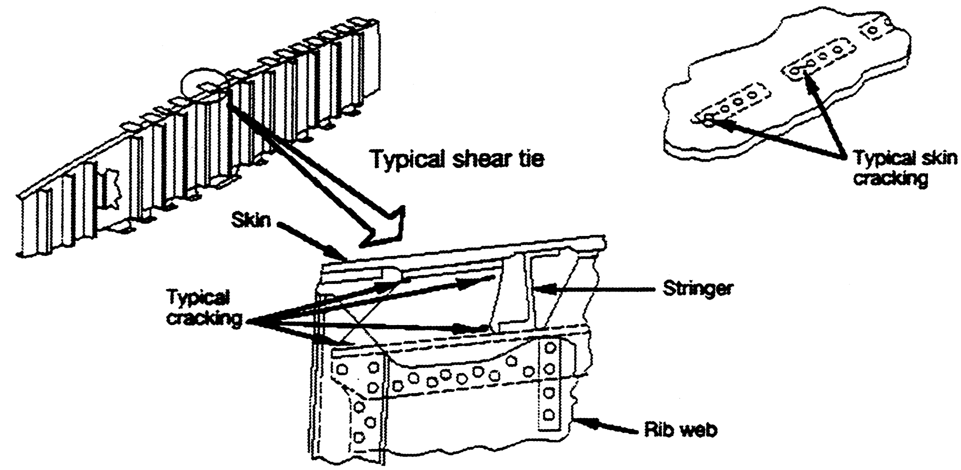
Figure 5.13 Skin at Runout of Large Doubler (MSD) Fuselage, Wing or Empennage



Type and possible location of MSD/MED
- MSD—skin and/or splice plate
  - Chordwise critical fastener rows
- MED—stringer runout of fitting
  - Fatigue-critical fastener holes at stringer and/or fitting

Service or test experience of factors that influence MSD and/or MED (examples)
- High load transfer
- Local bending

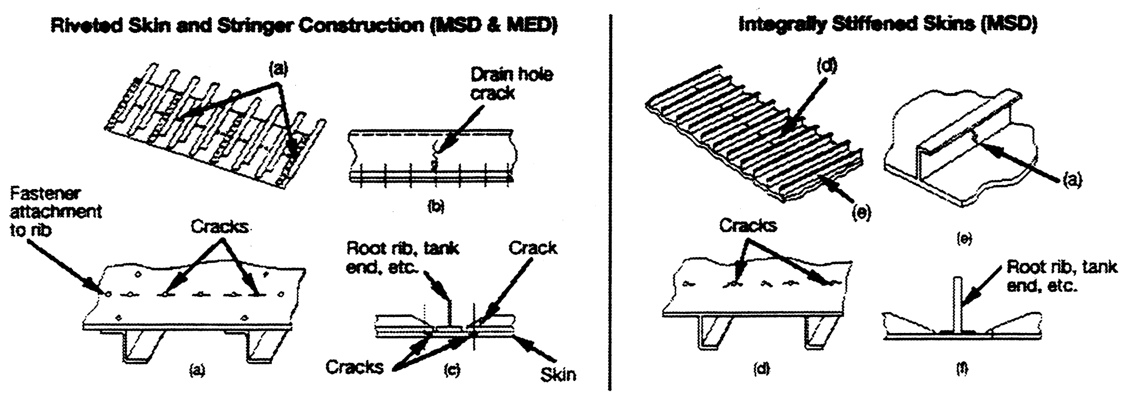
Figure 5.14 Wing or Empennage Chordwise Splices (MSD/MED)



Type and possible location of MSD and MED
- MSD—critical fasteners in skin along rib attachments
- MED—critical rib feet in multiple stringer bays (particularly for empennage under sonic fatigue)

Service or test experience of factors that influence MSD and MED (examples)
- Manufacturing defect—prestress due to assembly sequence
- Sonic fatigue (empennage)

Figure 5.15 Rib to Skin Attachments (MSD/MED)



Inherent fail safe and crack stopper characteristics
- MSD—chordwise cracks link up at
  - a) Rib attachment holes
- MED—
  - b) Drain or vent holes
  - c) Stiffener run-outs at root rib or tank end rib

Do not have inherent crack stopper characteristics of riveted skin and stringer construction
- MSD—Chordwise cracks link up at
  - d) Rib attachment holes
  - e) Drain or vent holes
  - f) Stringer run-outs at root rib or tank end rib
- MED—becomes MSD

Figure 5.16 Typical Wing and Empennage Construction (MSD/MED)

5.3 DSD COMBINED WITH MSD

5.3.1 Background

In the AAWG report of 1993 Reference [3], a requirement for the consideration of Discrete Source Damage (DSD) was included within the proposed guidelines for the evaluation of WFD, as follows:

'If applicable, each WFD susceptible area should be evaluated for a discrete source damage event due to uncontained failure of engines, fan blades and high energy rotation machinery. If the risk due to such an event is not acceptable for the specific area, the characteristic WFD parameters, fatigue crack initiation, MSD/MED propagation, and occurrence of WFD should be evaluated to include this damage source.'

Of the different types of DSD, only rotor burst was considered. This damage is the only one that could potentially result in scenarios that could interact with MSD/MED. Debris from a high energy event such as an uncontained engine failure has significant potential to degrade the residual strength of structural details susceptible to WFD. Other types of DSD, such as bird impact, do not have the same potential.

The risk due to such a combined event was quantified by the AAWG-TPG for several pre- and post-amendment 45 airplanes, and compared to the required levels in the airworthiness regulations. Six airplane types were included in this study, *viz.*

- Airbus A340
- BAC One-Eleven
- Boeing 727
- Boeing 737
- Boeing DC9/MD-90
- Lockheed L-1011

The results of these comparisons indicate that the generalized combined probability of failure is significantly below that required by the applicable regulations.

5.3.2 Technical Approach

Compliance with the current airworthiness regulations covering uncontained engine failures is demonstrated through two different parts of the Federal Aviation Regulations (FAR) and the Joint Aviation Requirements (JAR). In FAR/JAR 25.1309 References [5,6], system failures are assessed through the principle that there should be an inverse relationship between the severity of the effect of the failure on the airplane and the probability of its occurrence, *i.e.*

'(b) The airplane systems and associated components, considered separately and in relation to other systems, must be designed so that
(1) The occurrence of any failure condition which would prevent the continued safe flight and landing of the airplane is extremely improbable; and
(2) The occurrence of any other failure condition which would reduce the capability of the airplane or the ability of the crew to cope with adverse operating conditions is improbable.'

In the supporting Advisory Material, the probability of an extremely improbable failure condition is required to be not greater than 10^{-9} per flight hour, whilst the improbable failure condition has a probability not greater than 10^{-5} per flight hour.

Alternatively, FAR/JAR 25.903 References [7,8] calls for a safety analysis which considers the possible trajectory paths of engine rotor debris relative to critical areas, including damage to primary structure such as the pressure cabin, engine mountings and control surfaces. The rotor debris is modeled as a 'single one-third piece of disc', *viz.*

'It should be assumed that the one-third piece of disc has the maximum dimension corresponding to one-third of the disc with one-third blade height and an angular spread of ±3 degrees relative to the plane of rotation of the disc.'

There is an additional requirement to consider small pieces of debris with an angular spread of ±5 degrees. The AAWG chose to encompass this requirement by considering the one-third piece of disc with an angular spread of ±5 degrees.

In order to demonstrate compliance with this regulation, it must be shown that, in the event of an uncontained engine failure, the risk of a catastrophic structural or systems failure is maintained at some acceptable level, *i.e.*

'When all practical design precautions have been taken and the safety analysis made using the engine failure model ... shows that catastrophic risk still exists for some components or systems of the airplane, the level of catastrophic risk should be evaluated. It is considered that the objective of the requirement will have been met if ... there is not more than a 1 in 20 chance of catastrophe resulting from the release of a single one-third piece of disc.'

There is also a requirement in FAR/JAR 25.571, References [7,8], for the consideration of DSD. However, this regulation does not require consideration of environmental, fatigue or accidental damage in combination with DSD. In the past, regulators have normally accepted static analysis of the remaining structure, involving a 'scalping' cut from rotor debris passing through the structure, as demonstrating compliance with this rule.

In this assessment, the safety targets of 10^{-9} probability of failure per flight hour (FAR/JAR 25.1309) and 1 in 20 chance of catastrophe (FAR/JAR 25.903) have been selected to show compliance with the regulations.

5.3.3 Analytical Procedure

5.3.3.1 10^{-9} Probability of Failure per Flight Hour

Of all structural configurations, the most critical engine/airframe configuration with respect to the problem of DSD (e.g. potential damage) is that of a rear fuselage mounted engine. For the purposes of this discussion, the MD-90, a twin-engined airplane with the engines mounted in the rear fuselage is used.

An assessment of uncontained engine failure which results in the probability of failure per flight hour is a combination of the following components:

(a)Uncontained engine failure

(b) Phase of Flight

(c) Number of critical disks

(d) Critical spread angle

(e) Trajectory

(f) Critical Time

Based on these components, the Normal probability for a catastrophic airplane failure following a rotor burst is in the order of $4x10^{-11}$ for the MD-90. This probability is calculated in consideration of the following airplane/systems analysis

- Airframe Structure
- Avionics/Instrumentation
- Electrical
- Remaining engine
- Fire Protection
- Flight Controls
- Fuel System
- Hydraulics
- Pneumatics
- Multi System (worst case)

With the computation of a value less than $1x10^{-9}$, any possible interaction of MSD/MED with a discrete source event is non-existent based on today s regulatory standards.

5.3.3.2 1 in 20 Risk of Catastrophe

In the 1 in 20 calculation it is assumed that the uncontained engine failure event will occur, such that the probability of failure, P_{UEF}, becomes 1.0. The computation of the 1 in 20 risk of catastrophe involves the evaluation of the average risk from the phase of flight, spread angle, and trajectory. For the MD-90, the overall average risk, not considering the presence of MSD/MED is on the order of 0.04500 or 1 in 22.

The incremental effect of the possible presence of MSD/MED on this risk is computed considering the probability of the presence of MSD/MED, phase of flight, spread angle, and trajectory. The estimated total probability of having MSD/MED on an airplane being operated in the neighborhood of it s DSG is about 0.02 (based on a lognormal distribution with a standard deviation of 0.15). The total risk is given by:

$R = 0.045 + 0.02*0.045 = 0.0459$ or still about 1 in 22

This computation is conservative, based on the fact that if actual spread angles and trajectories were used for the threat of MSD, then the 0.045 would be somewhat reduced. Operation of the airplane would be permissible up until there was a total probability of MSD/MED of about 0.11. This would equate to around a 30% increase in the given DSG without impacting the 1 in 20 certification limit.

5.3.4 Environmental and Accidental Damage

The computations of the previous section were limited to a rotor burst scenario. There are other potential sources of damage that could lead to large-scale damage in the presence of MSD or MED. These include environmental degradation and accidental damage (including manufacturing damage).

As a result of the aging airplane activities started in 1988, maintenance programs have been modified to include corrosion prevention and control programs that effectively limit the amount of environmental degradation that can occur between maintenance visits. As part of the recommendations of this report, one element of an effective program to limit potential interaction between MSD/MED and environmental degradation is an effective corrosion control program. With this in place, a potential interaction between MSD/MED and environmental degradation is minimized.

Accidental damage, excluding obvious damage inflected on the ground, can be separated into two separate categories of events. The first type of accidental damage is that that might be caused by a dropped tool or other object, creating some significant but undiscovered damage to the structure. Maintenance programs are generally structured to find such events before they become critical through current scheduled inspections of the SSID or ALI program. This kind of damage is considered as local isolated damage and in general will never interact with MSD/MED damage scenarios. The other form of accidental damage is more of a concern since it in itself can be the source of MSD type events. This form of damage is the result of unapproved methods and procedures used either during manufacturer or maintenance. Damage such as scribe lines placed into structure while trimming adhesives or chemical milling masks are typical of the types of concerns this threat poses. There have been several notable in-service failures associate with this kind of damage. Unfortunately there is no way to predict the occurrence of this kind of damage. When this type of damage is found, it must be aggressively investigated and corrected on all airplanes that could be affected. The inherent fail-safe qualities of the structure should be more than adequate to contain this type of damage if the two-lifetime fatigue test rule is applied.

5.4 CERTIFICATION STANDARDS

Airplanes have been certified to a variety of standards over time with regards to damage sizes considered for residual strength evaluation. These standards have included:

- CAR 4b.270 (b)
  Ref. CAR 4b.270 (b), 1962:
  Fail safe strength. It shall be shown by analysis and/or tests that catastrophic failure or excessive deformation, which could adversely affect the flight characteristics of the airplane, are not probable after fatigue failure or obvious partial failure of a single principal structural element.

- FAR 25.571 Pre Amendment 45
  Ref. FAR 25.571 (c), 1967:
  Fail safe strength. It must be shown by analysis, tests, or both, that catastrophic failure, or excessive deformation, that could adversely affect the flight characteristics of the airplane, are not probable after fatigue failure or obvious partial failure of a single principal structural element......

- FAR 25.571 Post Amendment 45
  Ref. FAR 25.571 (c), 1978:
  Damage Tolerance (fail-safe) Evaluation. The evaluation must include a determination of the probable locations and modes of damage due to fatigue, corrosion, or accidental damage. The determination must be by analysis supported by test evidence and (if available) service experience. Damage at multiple sites due to prior fatigue exposure must be included where the design is such that this type of damage can be expected to occur. The evaluation must incorporate repeated load and static analyses supported by test evidence. The extent of damage for residual strength evaluation at any time within the operational life must be consistent with the initial detectability and subsequent growth under repeated loads. The residual strength evaluation must show that the remaining structure is able to withstand loads (considered as static ultimate loads) corresponding to the following conditions:

- FAR 25.571 Post Amendment 54
  Ref. FAR 25.571 (b), 1980:
  Damage-Tolerance Evaluation. The evaluation must include a determination of the probable locations and modes of damage due to fatigue, corrosion, or accidental damage. The determination must be by analysis supported by test evidence and (if available) service experience. Damage at multiple sites due to prior fatigue exposure must be included where the design is such that this type of damage can be expected to occur. The evaluation must incorporate repeated load and static analyses

supported by test evidence. The extent of damage for residual strength evaluation at any time within the operational life must be consistent with the initial detectability and subsequent growth under repeated loads. The residual strength evaluation must show that the remaining structure is able to withstand loads (considered as static ultimate loads) corresponding to the following conditions:

Both CAR 4b.270 (b) and FAR 25.571 Pre-amendment 45 require the applicant to consider that the failure or obvious partial failure of a single principle structural element would not be catastrophic to the airplane. Historically, these fail-safe damage sizes were related to large areas of structure being removed with positive static margins of safety with respect to 80% (CAR 4b and 100% FAR 25.571 Pre-Amendment 45) limit loads. The amount of structure removed was generally determined by a subjective criterion, namely that the structural failure or obvious partial failure represented by the structure removed would be easily detected and repaired before failure of the remaining structure.

The advent of fail-safe designs was a major step towards improved structural reliability and safety. However the fail-safe philosophy was not without its shortcomings. One of those shortcomings was made manifest in the crash of a 707 where a fail-safe load path failed leading to the loss of structural integrity of the horizontal stabilizer. As a result, the regulations regarding fail-safe structure were changed in 1978 through an amendment to FAR 25.571. This amendment (Amdt. 45) introduced certification requirements using damage tolerance concepts. At the time, this was deemed a significant technological advance since directed inspections were introduced to find and repair damage before loss of structural integrity could occur.

When the regulations were changed in 1978, the intent of 25.571 was also changed seemingly obscuring the requirement to design multiple load path, fail-safe structure. The damage tolerance evaluation recommended by AC 25.571 encourages applicants to consider these fail-safe concepts in the design. The two design philosophies, while broadly embracing the concept of allowing the structure to tolerate significant damage, differ significantly in how the capability is proven. Fail-safe methods employ the uses of ultimate strength capabilities of the structure with area out, whereas damage tolerance methods use yield strength or fracture toughness material properties. The damage capability of the structure demonstrated by one method generally does not have any comparison with the damage capability that might be determined using the other method.

While the requirements for initial certification require a damage tolerance evaluation, they normally do not require consideration of pre-existing fatigue damage including MSD and MED. These forms of damage are generally ruled out through the use of fatigue test evidence. The existence of MSD or MED fatigue cracks that might occur later in the service life of the airplane are of a considerable concern because they can affect the damage-tolerance damage sizes that the airplane is capable of sustaining.

5.4.1 Fail-Safe Analysis Damage Sizes

The 'fail safe' philosophy of Damage Tolerance used in the original certification relied on a static analysis with certain structural elements failed or partially failed. The 'failed' elements were assumed to carry no loads and the remaining, 'intact' structure was shown to be able to sustain a fail safe load level using a static structural analysis. The analysis assumes that there are no active cracks. The damage size chosen for this analysis was qualitative and was not specified by the regulations. The damage size chosen was large and considered 'conservative' to allow reliance primarily on general visual inspection (i.e. obvious partial failure). This allowed safe operation up to fail safe load levels until the damage was detected and repaired. Damage due to discrete sources, such as rotor burst, is also analyzed in this manner.

5.4.2 Damage Tolerance Analysis Damage Sizes

The damage tolerance approach utilizes crack growth analysis from an initial flaw size, to a critical crack length where limit load can just be sustained in the presence of an active crack tip. The requirements for damage tolerance certification are met when the applicant demonstrates that the inspection program developed as a result of the damage tolerance analysis will reliably detect a crack before it reaches the critical crack length.

The damage tolerance damage size is equivalent to the critical crack size. This damage size is highly dependent on a number of things including environment, material, design configuration, and structural loading. In general, applicants have a good deal of latitude in specifying the damage size on a case-by-case basis. Some applicants may not utilize the full residual strength capability of the structure in order to provide some level of conservatism in the inspection programs. In addition to fatigue related inspection programs, the structure is also inspected to detect corrosion and accidental damage

5.4.3 Survey of Certification Damage Size

Recently there has been a debate ongoing in the industry about how airplanes were certified to meet the fail-safe and damage tolerance requirements. The debate surrounds the damage sizes the industry used in the certification process. Two actions were taken by the AAWG to clarify this issue.

The AAWG tabulated damage sizes used in the certification analysis submitted by three different manufacturers. Each airplane had a different fail-safe/damage tolerance certification basis. The maximum damage size for each analysis location reported has been tabulated and plotted in order of descending crack size on the following figures:

Figure 5.4.3.1	Pre Amendment 45 (CAR 4b.270 (b))
Figure 5.4.3.2	FAR 25.571 (c) Post Amendment 45
Figure 5.4.3.3	FAR 25.571 (b) Post Amendment 54

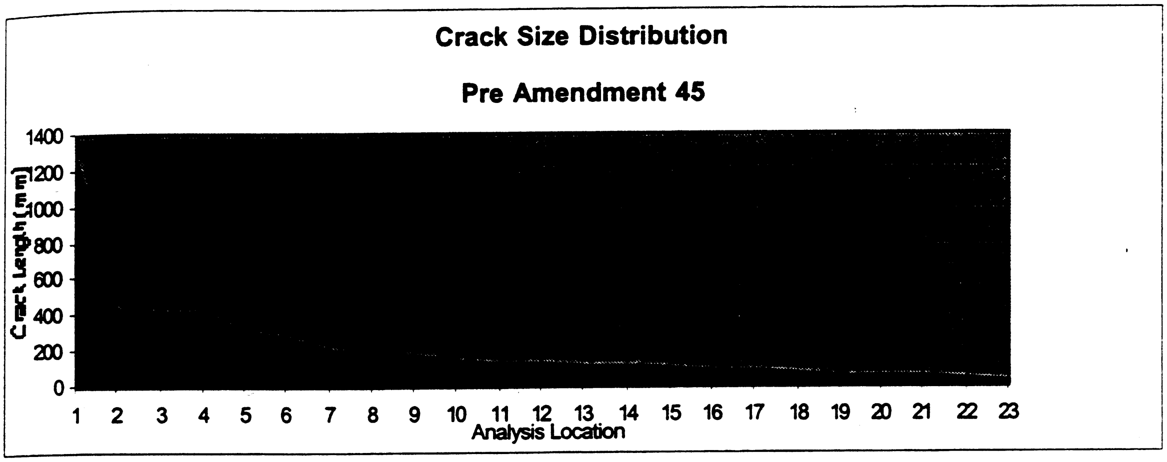


Figure 5.4.3.1 — Crack Sizes Used in Certification, Pre Amendment 45

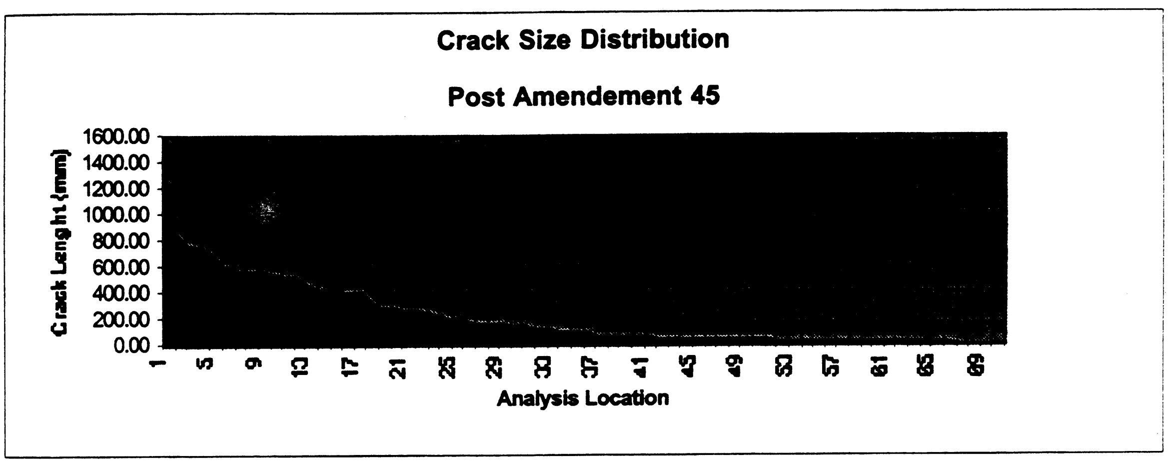


Figure 5.4.3.2 — Crack Sizes Used in Certification, Post Amendment 45

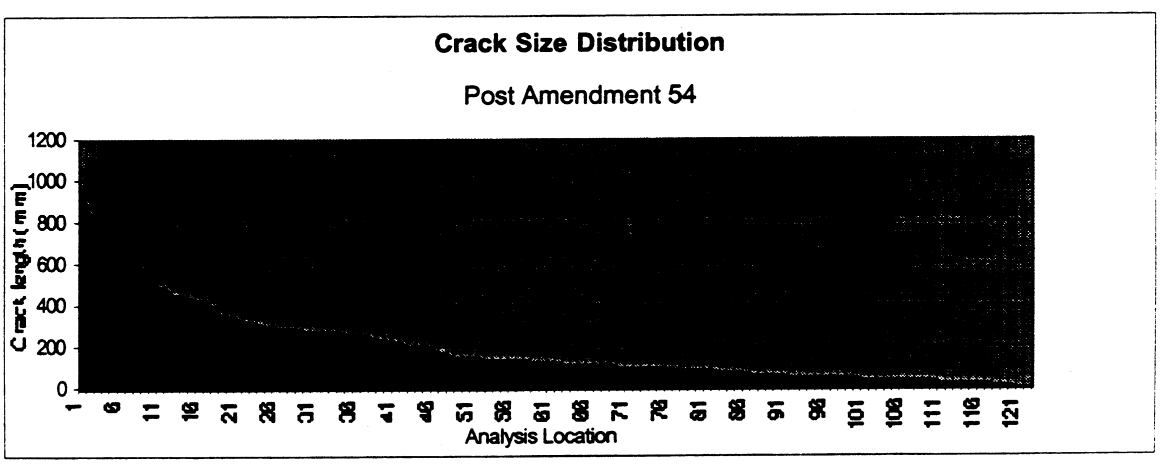


Figure 5.4.3.3 —Crack Sizes Used in Certification, Post Amendment 54

The following observations are drawn from review of these data:

- Charts are representative of industry practice for certification.
- Distributions are similar but independent of certification standards used.
- There is no typical damage size used in certification by the industry or required by the regulators.
- Damage size is highly dependent on location, design detail, and materials used.

5.4.4 Safety Enhancements

Airplanes certified prior to FAR 25.571 amendment 45 had supplemental inspection programs (SSIP) mandated by airworthiness directives. The SSIP programs effectively provided similar inspection programs to the inspection programs for airplanes certified post amendment 45. Since 1978, a number of new and innovative programs have been introduced that have enhanced the safety of the fleet for both pre- and post-amendment 45 airplanes. These programs include:

- Mandatory Modification Programs
- Corrosion Prevention and Control Programs
- Repair Assessment Programs
- SSID Revisions for obvious damage

These programs provide an increased level of surveillance. The increased level of surveillance, required by each of these programs at the airplane level, decrease the risk of having undetected structural degradation in high time airplanes with the net result of increasing safety within the fleet. While none of the programs is uniquely aimed at widespread fatigue damage, all have some inherent ability to detect MSD/MED before it becomes WFD.

New certification programs require the development of similar programs as part of the certification process in compliance with FAR 25.1529.

5.4.5 Conclusions

Over the past 20 years the regulatory certification requirements have shifted from a static strength fail-safe approach, comparing limit loads with ultimate static allowables, to damage tolerance evaluation comparing limit loads and fracture toughness. The fail-safe philosophy relies upon detection of obvious partial damage by routine inspections, whereas, damage tolerance relies upon directed inspections to detect smaller damage.

Review of the fail-safe/damage tolerance regulations, advisory material and the certification basis for numerous airplane models confirms that a FAA requirement that defines certification damage size does not exist. Certification damage size has always been subject to negotiation between the manufacturer and the regulator.

A common misconception is that all-primary structure has been certified using the classic fail-safe criterion of a two bay skin crack with a failed intermediate member being able to sustain limit load. In many cases this was an obtainable goal for fuselage structure designed by cabin pressure only, but the survey of certification damage sizes in section 5.4.3 shows this criteria was not necessarily applied for structure designed by the combination of flight loads and cabin pressure.

Damage tolerance critical crack criteria comparing limit loads to fracture toughness (active crack tip) should always result in a smaller critical damage size than a fail-safe criterion comparing limit loads and ultimate static allowables. The fact the current damage tolerance damage sizes are similar to prior fail-safe damage sizes is a tribute to the analysis and testing that has been done to increase the residual strength allowables.

There have been proposals within the industry that the original certification basis for an airplane model should be maintained in the presence of MSD/MED. This position with respect to certification damage size is unrealistic for two reasons. First, reanalysis of the structure using the current methods and fracture toughness allowables is likely to result in smaller allowable damage sizes than the old static strength based fail-safe analysis. Second, the presence of MSD/MED in the proximity of the crack tip can reduce the residual strength an additional 5 to 30%.

Whereas the original fail-safe criterion relied upon the detection of obvious partial damage by routine inspections the potential presence of MSD/MED will require directed detail inspections to maintain airworthiness.

5.5 MANAGEMENT OF MSD/MED IN THE FLEET

Since Aloha, known cases of multiple site damage/or multiple element damage have been effectively managed initially through implementation of mandatory inspections analogous to the monitoring periods recommended in Chapter 4.4. The inspection programs were typically implemented by the issuance of airworthiness directives by the regulatory authorities, or by alert service bulletins released by the OEM s. Monitoring periods are considered essential for safety management during the precursor stages (MSD/MED sources) of widespread fatigue damage, until terminating actions have been validated and implemented. Chapter 9.2 presents a detail discussion of the factors influencing lead times, which are necessary for effective long term WFD prevention. Interim safety measures via mandatory inspections are imperative to ensure safety as WFD-prone areas are identified by test, analysis, and/or service history and terminating modifications are accomplished. Monitoring periods should not be considered alternatives to terminating actions, but are deemed to be essential elements of the over-all WFD safety management plan.

5.6 SUPPLEMENTAL TYPE CERTIFICATES

5.6.1 Background

To understand the scope and magnitude of the supplemental type certificate problem, the AAWG obtained a copy of the *Summary of Federal Aviation Administration Supplemental Type Certificates*, published by the FAA in January 1998. From this list, a database of major alterations to principal structural elements was extracted (Appendix E), and sorted by OEM and airplane model. Broad categories of structural alterations that could affect, alter or nullify recommended OEM widespread fatigue damage audits were then identified.

5.6.2 Discussion

The majority of structural STC s with WFD concerns can be grouped into the following categories:

- Passenger-to-freighter conversions (including addition of main deck cargo doors).
- Gross weight increases (increased operating weights, increased zero fuel weights, increased landing weights, and increased maximum take-off weights).
- Installation of additional fuselage cutouts (passenger entry doors, emergency exit doors or crew escape hatches, fuselage access doors, cabin window relocations).
- Complete re-engine and/or pylon modifications.
- Engine hush-kits and nacelle alterations.
- Wing modifications such as the installation of winglets or changes in flight control settings (flap droop), and alteration of wing trailing edge structure.

Many of these STC s also include companion operational mission changes affecting original OEM load/stress spectrums.

Some STC s were found to have changed large areas of fuselage from externally visually inspectable structure to hidden details. Reliance on operator s baseline maintenance program visual inspection requirements may be critical elements of OEM WFD audits, especially during the reliance on monitoring periods to validate analysis or test MSD/MED source predictions. STC s may invalidate these safety management service action assumptions; and would require additional WFD analysis and/or testing. STC s that change baseline maintenance requirements such as frequency of detail visual inspections, or other inspection methods must be evaluated with respect to OEM WFD safety management programs. STC s must be reviewed to account for differences with the OEM baseline maintenance program requirements.

STC alterations creating or affecting principal structural elements must be evaluated to demonstrate the same confidence level as the original OEM structure. This confidence level must be equivalent to that obtained by a two DSG full-scale fatigue test without evidence of MSD/MED occurring in the STC affected structure.

All models identified by AAWG, as candidate WFD assessment fleets had STC changes affecting primary structure, since entering service. A listing of STC s compiled from the January, 1998 edition of the Summary of Federal Aviation Administration Supplemental Type Certificates that could appreciable affect OEM WFD audits of principal structural elements are given in Appendix E. Note: This list contains only modifications accomplished on more than one airplane, single airplane STC alterations are not included.

5.6.3 Recommendations

All STC s affecting primary structure should have widespread fatigue damage assessment. The AAWG recommends that the following criteria be used for determination of which STC design characteristics and features would require widespread fatigue damage assessment:

- Major alteration to airplane structure in which a new or modified principal structural element (PSE) is created.

  Example: Freighter conversion with the addition of an outward opening, hoop tension main deck cargo door and door surround structure. The main deck door and door surround structure are new PSEs.

- Major alteration to airplane structure in which the alteration was not certified to damage tolerance requirements.

  Example: Freighter conversion with the addition of an outward opening, hoop tension main deck cargo door with certification prior to application of FAR 25.571, Amendment 45 (pre-1978), or those STC s that have not had structural reassessments to damage tolerance standards (and do not have resulting supplemental structural inspection programs, *with consideration for WFD sources,* implemented).

- Major alteration to airplane structure that appreciably changes the load and stress distribution, load and stress magnitude, load spectra and stress history, stiffness, mission severity, adversely affects inspectability or continued airworthiness limitations of primary structure.

Example: Addition of a winglet to a wing that changes the wing center of pressure, stiffness and spectrum (and may introduce new failure modes).

- Major alteration to airplane structure that contains design features identified by AAWG as susceptible to sources (MSD/MED) of widespread fatigue damage (See Section 5.2).

Example: Freighter conversion adding fuselage plug with main deck cargo door with new skin joints, and hoop tension concentrated load path latch hooks on door surround structure.

5.6.4 Compliance Time for STC WFD Assessment

The compliance time for the widespread fatigue damage assessment on STCs affecting primary structure should be the same calendar compliance as the original structure. The FAA tasking statement for rulemaking and advisory circular activities should state clearly that STCs would be included in the final rulemaking. This statement would alert operators and STC holders of the forthcoming regulatory action, and would strongly recommend that the assessment programs begin (similar to actions already being undertaken by the OEM s for WFD assessment of the type design structure). This notification would give operators and STC holders approximately 3 years to complete the Engineering assessment necessary to meet any final rule requirements, assuming work was begun when the FAA WFD tasking statement was published in the Federal Register. Note: Establishment of design goals for STCs affecting primary structure will be required as part of the rule making activity to follow on from this tasking. Establishment of design goals for STCs will effect both existing and future STC modifications.

5.6.5 Summary

Supplemental type certificate alterations to airframe structure can appreciably affect, alter or nullify widespread fatigue damage programs developed by the OEM. Any comprehensive widespread fatigue damage safety management program must include airframe structure that has been altered by supplemental type certificates. Criteria have been established for determination of categories of STC alterations that must be assessed for widespread fatigue damage. WFD audit requirements for STCs should be the same standard and timelines as original model specific programs. STC alterations creating or affecting principal structural elements must be evaluated to demonstrate the same confidence level as the original OEM structure. This confidence level must be equivalent to that obtained by a two DSG full-scale fatigue test without evidence of MSD/MED occurring in the STC affected structure. Responsibility for completion of WFD audits on STCs will ultimately be the operator s (implemented by FAR 121 and/or 25.1529 rulemaking).

5.7 COMBINATION OF MSD/MED SCENARIOS

The AAWG examined the issue of whether or not it was possible to have a simultaneous occurrence of MSD and MED in a single principal structural element. The AAWG concluded that there was a distinct possibility that this could occur on some details that were equally stressed. This scenario should be considered in developing appropriate service actions for a PSE should this event seem likely.

It is suggested that if an area is potentially susceptible to both MSD and MED, then both problems be worked independently. If the thresholds for both MSD and MED indicate a high probability of interaction, then this scenario must be considered.

6.0 TECHNOLOGY READINESS

6.1 1998 ASSESSMENT OF TECHNOLOGY AVAILABLE

6.1.1 1993 Recommendations

The Industry Committee on Widespread Fatigue Damage (ICWFD) which worked under the umbrella of the AAWG defined research recommendations in their final report issued 1993. The research goals and subjects of interest for the industry for evaluation of Widespread Fatigue Damage were defined and are summarized in the table below.

Analysis goals	Research subjects
Initiation of MSD/MED	
Predict realistic cracking scenarios Define a lower limit for MSD/MED initiation	Cracking location Coupon testing for each susceptible area Statistical analysis Guidance material Scatter on material data Redistribution of loads
Propagation of MSD/MED	
Predict cracking development Step towards WFD occurrence limit Monitor MSD/MED	Short cracks: Influencing factors Short cracks: Parametric coupon tests Short cracks: Scatter in material data SIF: Non uniform cracks in complex geometry SIF: Crack interaction SIF: Crack deviation/ bulging/ cold working/ interference SIF: Redistribution of loads Scatter in material data
Residual strength	
Predict residual strength in presence of MSD/MED	RS of ductile materials in the presence of MSD/MED RS validation on large scale components RS: consideration of crack configuration/ curvature/ load transfer RS: consideration of in plane and pressure loadings
Risk analysis	
Predict WFD based on randomisation of WFD parameters	Common understanding of basic rules for risk analysis Develop guidance material Specific methods for WFD parameters
Discrete source	
Assess the real concerns with this issue Predict residual strength	Common industry data on discrete source Extend/ location/ type of damage determination Probability analysis (occurrence/ location/ extent)

6.1.2 1998 Status

As a result of worldwide aging airplane activities, research programs were initiated in the United States and in Europe. Programs such as the FAA«s National Aging Aircraft Research Program (NAARP), the European Group for Aeronautical Research and Technology in Europe (GARTEUR) Action Group and the European Brite EuRam Structural Maintenance of Aging Aircraft (SMAAC) Project were established.

The NAARP consists of seven major subjects, one of which deals with Structural Response Modeling and Simulation . Within this project the WFD research activities cover deterministic methodologies as well as probabilistic methodologies. Historically, the FAA research activities in the WFD area have been focussed on residual strength analysis and prediction. Additionally methodologies for crack growth analysis were developed. Furthermore, in 1996 the FAA and NASA jointly funded a contract with an American manufacturer to develop and validate a procedure for the prediction of the point of WFD. This activity included the evaluation and validation of several crack growth and residual strength analysis methods such as equivalent initial flaw size determination, FASTRAN, crack growth criteria T* and Crack Tip Opening Angle (CTOA), Finite Element Alternating Method (FEAM), FRANC2D, FRANC3D/ STAGS. The research work included a large number of coupons, flat panels, stiffened panels, sub-scale cylinders, unstiffened curved panels, stiffened curved panels and aft pressure bulkhead panels sub-scale which were tested regarding fatigue, crack growth and residual strength to support and validate the analytical work. Additionally, probabilistic methodologies can predict the time-dependent probability of the point of WFD, the time dependent distribution of the airplane s residual strength, and the impact of inspections on the structural integrity of the airplane.

An initial collaborative program undertaken by the European aerospace community was started in 1994. This program was supported by the GARTEUR to increase the understanding of MSD in highly loaded joints, and to reduce some of the deficiencies in existing methodologies for predicting the development of MSD in such components. The activities of the project were completed in 1996.

Following the dissolution of the GARTEUR Action Group, financial support for continued collaboration in the field of WFD was secured from the European Commission under the Fourth Framework Program for Research and Technological Development (1994-1998). The GARTEUR activity, and the insights into the problem of MSD, which arose in consequence, were major contributing factors in the success of this proposal. The Brite/ EuRam project (SMAAC) which began in 1996 has the objective of develop engineering tools for the assessment of maintenance actions (inspection and repair) for aging airplanes, and to derive novel design methods to extend the design life of future airplanes with respect to WFD.

The duration of the SMAAC project was originally planned to cover three years, and the project will therefore continue until the beginning of 1999. By the end of the SMAAC project, it is anticipated that a range of theoretical models will have been developed to assess fatigue crack initiation and propagation in aging airplane structures, in order to determine the maintenance actions required to preclude the point of WFD. These models cover the following areas: multiple fatigue crack initiation (probabilistic analysis), multiple fatigue crack growth (deterministic analysis), residual strength in the presence of MSD/MED (deterministic analysis) risk assessment and overall models.

The data base of experimental evidence of MSD/MED has also been increased through an extensive series of fatigue crack growth and residual strength tests, undertaken specifically for the SMAAC project. These test programs are principally intended to provide information to support the development of the analytical models. Therefore they consist of generic specimens, rather than specific airplane components, such as simple specimens (initiation and growth of MSD) and complex specimens (residual strength of representative stiffened panels, i.e. flat stiffened panels with lap or scarf joints, and curved panels with stiffeners, frames and longitudinal lap joints).

Linear elastic fracture mechanics methodologies have been generally adopted in the analytical approaches developed within both the GARTEUR and SMAAC projects, with stress intensity factor solutions obtained through a range of techniques of increasing complexity, such as compounding, stress functions, boundary element analysis and finite element analysis. By the end of the SMAAC project, the analytical models produced by the various partners will have been validated against these experimental results, which should also establish the level of sophistication required to address each of the given problems.

6.1.3 Future Research

With respect to the research programs described, the results of the round robin tests, see Section 8.6, and the overview of OEM methodologies, see Sections 8.1 through 8.5, the following research is recommended with the understanding that this research may not affect the first round of audits due in three years:

- Every effort should be made to make data from tests conducted in all research programs available at the earliest possible time before formal reports are issued.
- Extension of the analysis methods to thicker (wing) structure and verification by representative testing.
- Provision of equivalent initial flaw size (EIFS) data for all relevant alloys and fasteners. Fractography after fatigue testing to obtain cracks sizes versus time data, which each OEM could use to substantiate crack growth model and rate data.

- Development of small crack da/dN data for some specific materials and configurations.
- Determination of the scatter in the initiation of MSD/MED for different structural configurations as developed in section 6.1.4.
- Tests currently funded, involving lead crack link-up, should be accomplished as soon as possible to support the first round of audits due in three years.

6.1.4 Research Proposal

Several manufacturers use a stochastic approach based on the Monte-Carlo simulation procedure to determine damage scenarios, which are the basis for the WFD evaluation. A series of initial damage scenarios are randomly defined taking material scatter into account.

Generally the material scatter of small coupon specimens is used, i.e. the scatter of cycles to failure of the specimens.

It is recommended the variability of MSD cracking for typical high loaded fuselage joints with high secondary bending be investigated. The investigation consists of constant amplitude tests with small and large coupons and of the comparison with tear down results from real airplane or large curved stiffened panel tests.

The following test program is proposed:

- Constant amplitude tests with small coupons (width one rivet pitch) up to crack initiation, microfractographic investigations to determine the life up to 0.005 and 0.05 crack length.
- Constant amplitude tests with large coupons (width six rivet pitches) up to crack initiation, microfractographic investigations to determine the life up to 0.005 and 0.05 crack length.
- Constant amplitude tests with small coupons (width one rivet pitch) up to failure.
- Constant amplitude tests with large coupons (width six rivet pitches) up to failure.
- Tear down and microfractographic investigation of realistic airplane structure to determine the life up to 0.005 and 0.05 crack length.

The goals of these investigations are to determine the scatter of the fatigue lives up to first 0.005 flaw, first 0.05 flaw and up to failure of the specimens and to compare the results with either data from in-service airplane or representative large panel tests. The joint configuration and the production standard has to be identical for coupons and airplane structural. However, the effect of production changes on the scatter should be investigated additionally.

6.1.5 Residual Strength

The presence of MSD adjacent to a lead crack has a significant influence on the residual strength capability of the structure. Former concepts for residual strength evaluation used for type certification considered single damages. These concepts, e.g. Feddersen concept or R-curve approach, are not adequate for the residual strength evaluation in the presence of MSD.

More sophisticated approaches have been developed, e.g. J integral, T* integral, CTOA, elastic-plastic FE analysis, plastic zone link-up. To support these new approaches significant testing with flat and curved panels has been conducted in frame of the US National Aging Aircraft Research Program and the European Brite-EuRam SMAAC (Structural Maintenance of Aging Aircraft) Program. One of the purposes of the test programs is to demonstrate the residual strength capability of airplane structure potentially susceptible to WFD and to verify the concepts, methods and analysis tools for residual strength evaluation.

The U.S. National Aging Aircraft Research program includes testing of flat panels with lap joints, butt joints, and double shear joints to study residual strength affects of MSD. Additional residual strength tests of curved panels with spectrum loading that are representative of typical airplane structure will be conducted with MSD and MED present.

The European research program contains residual strength tests with flat specimens containing open holes, lap joints, double shear joints, butt joints and asymmetric joints for studying different aspects of the residual strength issue in the presence of MSD. Furthermore stiffened flat and curved panels with typical structure were tested under real loading. This structure represents the major fuselage and wing joints of existing small and large European airplanes.

Besides the tests included in the research programs, further residual strength tests are planned by the European and US manufacturers with specific structure of the airplane types to be evaluated regarding WFD. These tests will include major fuselage and wing joints and will validate the WFD analysis for these joints as well as allowing application of the experience to the remaining structure.

6.2 1998 AND NEAR FUTURE INDUSTRY NDI CAPABILITIES

The AAWG reviewed current and future industry NDI capabilities in order to establish a baseline detectable flaw. The ability to detect small flaws in an inspection program is a key element in the decision an OEM must make in determining appropriate service actions. If flaws cannot reasonably be detected, then rework is the only recourse. If the flaws can be detected well before critical length, then a monitoring period approach could be employed to manage the service problem.

6.2.1 NDI Round-Robin

In order to determine the readiness of available NDI technology for use in the detection of MSD/MED, the AAWG devised a 'round-robin' survey, consisting of four sample problems on crack detectability in typical structural configurations. These problems were sent to each OEM (Airbus Industrie, Boeing Commercial Airplane Group and Lockheed Martin Aerospace Systems) and the FAA Technical Center for evaluation. In addition, the participants were invited to anticipate the minimum detectable crack size possible after 1 year and 5 years from the time of the survey, given the direction of current research and development in the NDI area. The basic problem statement and accompanying sketches are shown in Figures 6.2.1 and 6.2.2, respectively.

The results of this survey are presented on the following four pages, in which the estimates of crack detectability provided by each participant have been consolidated into a single minimum detectable crack size for each configuration. The detectable crack sizes specified by the OEMs in the survey were generally consistent; in most cases where differences existed, the consolidated results are the largest of the crack sizes provided, with 90/95 probability data used where possible. The information is believed to be conservative; it should be possible to stipulate smaller detectable crack sizes if the exact structural location is specified, rather than the typical scenarios suggested within this survey.

The NDI specialists participating in this survey repeatedly advised caution in the interpretation of the information supplied in response to the AAWG inquiries. The data sheets given on the following pages relate to crack detectability under controlled (laboratory) conditions, without consideration of other variables such as human factors, inspection surface conditions, and operator experience level. Furthermore, the data are based on the optimum NDI method, using 'state-of-the-art' equipment that may not be available to many operators. The simple numerical estimates of crack detectability presented in this section are therefore considered to be useful only as illustrations of typical NDI capability, and should not be used directly in engineering situations without an understanding of the many factors which influence non-destructive inspections.

Nevertheless, the participants appreciated that the information on crack detectability was required by the AAWG in assessing the capability of the industry to ensure the elimination of the potential for WFD from the commercial airplane fleet. The survey provided the AAWG with a useful opportunity to discuss the problem directly with those NDI specialists in the best position to supply those data.

A complete compendium of data from each manufacturer is given in Appendix F.

NDI Round Robin
NDI Technology Issues For Discussion

- In your perception what are the NDI Issues associated with the detection of WFD?
  - Multiple Site Damage (MSD)
  - Multiple Element Damage (MED)
- Summarize your major R&D thrusts in NDI that might aid in detection of precursory forms (e.g. MSD and MED) of WFD.
  - IRAD
  - CRAD
- What size of flaws can be reasonable detected in airplane structure (on airplane), with say 90 percent confidence, and 95 percent reliability for the cases illustrated by the figures on the next page?
- What would be the effect on the POD curve for a single detail verses multiple details (e.g. lap splices)?
- In your research initiatives how are the positive (both true and false) NDI findings enunciated and recorded?
- What are the estimated costs Vs detection capability on airplane structure for each of your research initiatives?
- What is the largest crack that can be missed in each of your methods?
- Have the methods you propose been validated on airplane type structure?
- With current research thrusts, what size flaws do you expect to be able to detect in:
  - 1 year?
  - 5 years?

Figure 6.2.1.1 NDI Technology Issues For Discussion

AAWG-TPG
ACTION ITEM 4-10
NDI FIGURES

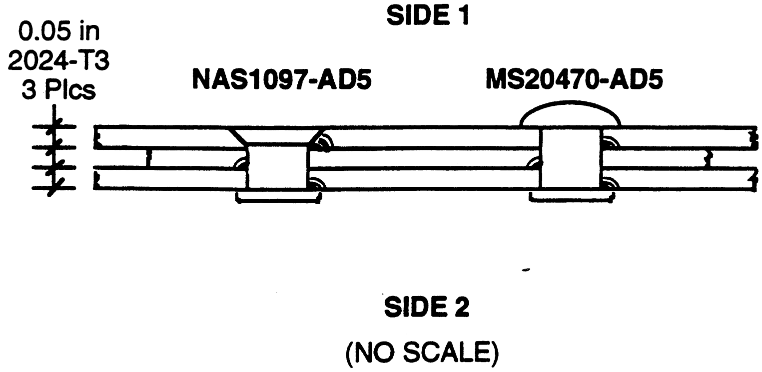


FIGURE 1. FUSELAGE TYPE STRUCTURE

Problem Statement:

(1) For the six flaw locations shown in Figures 1 and 2, determine the 90,95 flaw size using your best candidate techniques from both SIDE 1 and SIDE 2?
(2) What is the estimated false alarm rate?
(3) What is the largest flaw that could be missed?

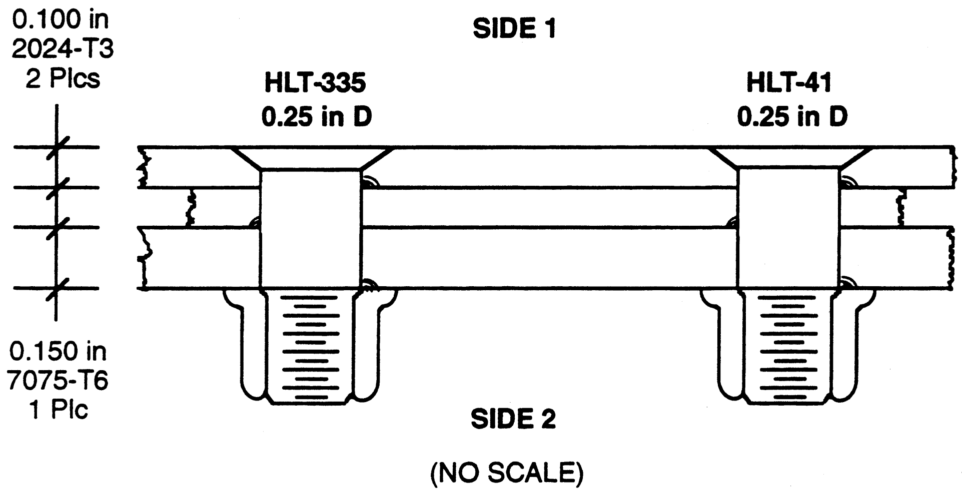


FIGURE 2. WING/EMPENNAGE TYPE STRUCTURE
Figure 6.2.1.2 NDI Example Problems

6.2.2 Conclusions

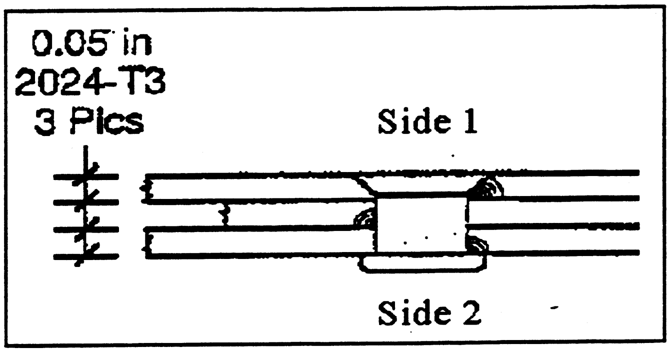
The minimum detectable crack size was not found to have decreased significantly from the limits given at the time of the ICWFD report of 1993, despite the extensive research effort of the past five years. The current 'state-of-the-art' in NDI technology needs significant improvement in both detectability and reliability in the next three years to support audit alternatives for WFD.

The highest potential to achieve the necessary improvements in crack detectability is in the field of semi-automated eddy current systems, incorporating new sensor technologies, multiple frequency application, automated signal pattern evaluation algorithms and documentation features. These advances are expected to result in a significant (20 to 40%) decrease in detectable crack size within the next five years with improved reliability.

Widespread Fatigue Damage Detectability – Industry Estimate

(All cracks measured from shank of fastener, cracks numbered in ascending order from inspection side)

Case 1: Aluminum NAS1097-AD5 flush rivet



This data represents detectability under controlled (laboratory) conditions, using the optimum NDT method.

Human factors, inspection surface conditions, operator experience level, and other variables have not been considered.

Side 1:

	Industry Estimate	
	Inches	**mm**
CRACK 1:	**0.05**	**1.3**
	0.04	*1.0*
CRACK 2:	0.25	6.4
	0.15	*3.8*
CRACK 3:	0.31	7.9
	0.2	*5.1*

Side 2: Dimensions shadowed by upset rivet assumed to be 0.020 (0.5mm)
Rivet upset assumed to be irregular.

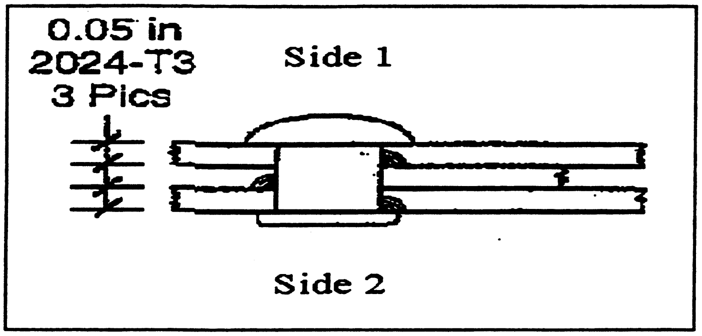
	Industry Estimate	
	Inches	**mm**
CRACK 1:	0.1	2.5
	0.09	*2.3*
CRACK 2:	0.25	6.4
	0.15	*3.8*
CRACK 3:	0.31	8.0
	0.25	*6.4*

Key: current capabilities in plain text, *five year projections in italics,* **90/95 crack lengths in bold**

Widespread Fatigue Damage Detectability – Industry Estimate

(All cracks measured from shank of fastener, cracks numbered in ascending order from inspection side)

Case 2: Aluminum MS20470 protruding head rivet



This data represents detectability under controlled (laboratory) conditions, using the optimum NDT method.

Human factors, inspection surface conditions, operator experience level, and other variables have not been considered.

Side 1: 0.078" (2.0 mm) = dimension shadowed by MS20470 protruding head

	Industry Estimate	
	Inches	**mm**
CRACK 1:	0.12	3.0
	0.09	*2.3*
CRACK 2:	0.25	6.4
	0.2	*5.1*
CRACK 3:	0.35	8.9
	0.25	*6.4*

Side 2: Dimension shadowed by upset rivet assumed to be 0.078" (2.0 mm). Rivet upset assumed to be irregular.

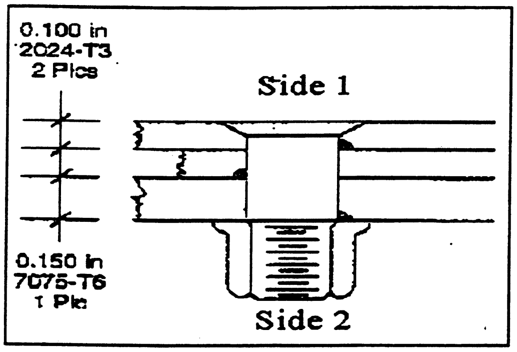
	Industry Estimate	
	Inches	**mm**
CRACK 1:	0.141	3.6
	0.098	*2.5*
CRACK 2:	0.25	6.4
	0.2	*5.1*
CRACK 3:	0.31	8.0
	0.25	*6.4*

Key: current capabilities in plain text, *five year projections in italics,* **90/95 crack lengths in bold**

Widespread Fatigue Damage Detectability – Industry Estimate

(All cracks measured from shank of fastener, cracks numbered in ascending order from inspection side)

Case 3: Titanium HLT-335 flush 0.250" (6.3 mm) diameter fastener



This data represents detectability under controlled (laboratory) conditions, using the optimum NDT method.

Human factors, inspection surface conditions, operator experience level, and other variables have not been considered.

Side 1:

	Industry Estimate		If fay sealed, with transducer access	
	Inches	mm	Inches	mm
CRACK 1:	0.2	5.1		
	0.15	*3.8*		
CRACK 2:	0.4	10.2	0.31	8.0
	0.35	*8.9*		
CRACK 3:	0.79	20.0		
	0.5	*12.7*	***0.1***	***2.5***

Side 2: Dimension shadowed by fastener collar assumed to be 0.125" (3.2 mm). No sealant cap present.

	Industry Estimate		If fay sealed, with transducer access	
	Inches	mm	Inches	mm
CRACK 1:	0.15	3.8		
	0.13	*3.3*		
CRACK 2:	0.425	10.8	0.39	10.0
	0.375	*9.5*		
CRACK 3:	0.675	17.1		
	0.625	*15.9*		

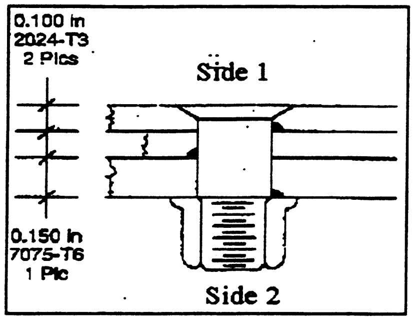
NOTE: Inspection for crack 3 from side 2 is a very unlikely inspection scenario.

Key: current capabilities in plain text, *five year projections in italics*, **90/95 crack lengths in bold**

Widespread Fatigue Damage Detectability – Industry Estimate

(All cracks measured from shank of fastener, cracks numbered in ascending order from inspection side)

Case 4: Steel HLT-41 flush 0.250" (6.3 mm) diameter fastener



This data represents detectability under contrc (laboratory) conditions, u the optimum NDT metho

Human factors, inspectio surface conditions, operε experience level, and oth variables have not been considered.

Side 1:

	Industry Estimate		If fay sealed, with transducer access	
	Inches	**mm**	**Inches**	**mm**
CRACK 1:	0.1	2.5		
	0.1	*2.5*		
CRACK 2:	0.3	7.6	0.31	8.0
	0.2	*5.1*		
CRACK 3:	0.55	14.0		
	0.35	*8.9*	***0.1***	***2.5***

Side 2: Dimension shadowed by fastener collar assumed to be 0.125" (3.2 mm). No sealant cap present.

	Industry Estimate		If fay sealed, with transducer access	
	Inches	**mm**	**Inches**	**mm**
CRACK 1:	0.125	3.2		
	0.1	*2.5*		
CRACK 2:	0.425	10.8	0.39	10.0
	0.375	*9.5*		
CRACK 3:	0.675	17.1		
	0.625	*15.9*		

NOTE: Inspection for crack 3 from side 2 is a very unlikely inspection scenario.

Key: current capabilities in plain text, *five year projections in italics,* **90/95 crack lengths in bold**

6.3 NDI Improvements with Regard to the Challenge of MSD

Residual strength reductions due to multiple site damage scenarios require appropriate measures in order to maintain the structural integrity over the period of planned flight cycles. Among other measures, improved and advanced NDI technologies is a candidate with a promising potential for the detection of MSD. Significant improvements in comparison with the currently available NDI technologies are expected from using the following technologies and computer software algorithms:

- Semi-automatic crack detection systems (manually operated probe systems with fully automated signal pattern evaluation)
- Improved multiple frequency eddy current systems
- SQUID sensor technology

All of the technologies mentioned above already exist today and have entered into advanced field trials. Further information on each of these technologies is given below. In order to fulfill the requirements for detection systems capable of reliably resolving the cracks associated with MSD, the improved NDI technologies must provide:

- A significant improvement in resolution capacity (20 to 40% over today s capability)
- Low false call rates (<1%)
- A reduction of the human factors element
- Semi-automatic signal pattern evaluation

Although new NDI technologies will certainly improve the detectability of fatigue cracks hidden in the second and third layer of structure, the highest potential for achieving the required improvements is seen in the field of semi-automated NDI systems incorporating new sensor technologies, multiple frequency eddy current applications, automated signal pattern evaluation algorithms and documentation features. Engineers involved in the NDI development process should interact with other disciplines that rely on their technology in order to establish requirements for detectability and reliability in the qualifications of new NDI technology. Such requirements, for future research, should be structured around the five most critical locations potentially susceptible to MSD for each OEM. The requirement should contain details about the manufacturing of the structure, expected flaw locations and direction of initiation and the expected crack shape over time.

The necessary improvements can be achieved within two to four years, provided that the activities of both American and European research institutes, academia, and OEMs are coordinated and financed by the organizations involved in aging airplane development activities.

1. Semi Automated Crack Detection Systems

This system is based on eddy current and/or ultrasonic techniques. Semi automated systems are a combination of manually operated probes and fully automated measuring devices with software based on-line evaluation and classification of signal patterns. The fully automated measuring and evaluation algorithms of these crack detection systems eliminate the element of human factors to a high degree, thus making the inspection results much more reliable in comparison to current techniques. With the existing systems available in America and Europe combined with necessary improvements with regard to small crack detectability, semi automatic systems will become a major element in NDI applications for MSD detection purposes.

2. Improved Multiple Frequency Eddy Current Systems

Specialized vendors have offered various types of equipment for both rotating and sliding probe systems that make use of multiple frequency eddy current.

Use of these systems during teardown inspections and coupon tests have clearly demonstrated the advantages of multiple frequency systems with regards to:

- The identification of cracks
- The distinction between cracks, corrosion, permeability and geometry effects
- The determination of defect depth and size in hidden layers with an acceptable range of error.

As the existing systems have already demonstrated clear advantages in comparison with conventional ones, the development potential for multiple frequency eddy current applications should be thoroughly examined and exploited for MSD detection purposes.

3. SQUID Sensor Technology

SQUID technology (Super-conducting Quantum Interference Device) uses an extremely sensitive measuring element for the detection of magnetic field variations in combination with eddy current application.

This technology, driven by the academics, equipment manufacturers and OEMs in Europe, is offering a promising potential for improvements in fatigue crack detectability, particularly in hidden positions of lap splices and thicker multiple structural elements.

Due to the latest achievements in minimizing the dimensions of the cryostat device, the equipment has become portable so that it can be used under normal in-service maintenance conditions. Comparisons of PODs as achieved with the SQUID technique versus conventional equipment are showing equivalence on the tested structures but the SQUID technology is not yet considered to have reached the limits of its capabilities.

7.0 AIRPLANE SPECIFIC EVIDENCE OF MSD/MED

7.1 HEALTH OF FLEET WITH REGARD TO WIDESPREAD FATIGUE DAMAGE SOURCES

It can be easily demonstrated that a significant effort is being made in the industry to assess, inspect, and modify airplane structure to maintain the highest level of safety. Most of the individual activities, which are part of the larger effort, can trace at least part of their origins to an early report and resolution of a discrete problem by an operator/manufacturer team. While not geared specifically to identification of potential WFD issues, the current system of operator/manufacturer communications has in retrospect been quite useful in identification and resolution of a number of issues which can today be classified as WFD concerns. A discussion of some examples will be covered in section 7.3.

7.1.1 Background -- The Communication Process Today.

The basic processes currently used to facilitate these operator/manufacturer communications have changed little over the years, although technology has improved the speed of communication. Also, an increasing awareness of the potential long-term effects of structural repairs has caused a corresponding increase in the number of issues presented to the manufacturer.

In order for the manufacturer to conduct the necessary analyses on individual airplanes and begin or continue an assessment of fleet impact, several key data elements are documented:

- Operator
- Aircraft Line No.
- Hours/Cycles
- When/How discovered
- Damage Description; location, geometry, size, related factors such as adjacent damage, prior occurrences, mitigating factors
- Sketches/photos may be submitted
- A proposed repair may also be suggested

The manufacturer catalogs the information and generates the necessary data to substantiate a disposition of the condition:

- Repair design
- Special conditions/processes such as cold working, specific shoring requirements, etc.

- Follow-up inspections, if required
- OEM analysis and assessment of failed component(s).

The manufacturer may initiate additional communications with other operators to solicit feedback on possible related occurrences. These related occurrences may not have been previously reported for a variety of reasons, such as operator decision to replace versus repair, or damage was detected and corrected at an earlier stage with existing data.

The manufacturer combines this feedback with earlier reports, and assesses the issue for possible further action. Dialog with operators is maintained through a variety of methods including manufacturer representatives, Telex, operator letters, and contact through groups like the STGs. All are valid means for information collection and dissemination.

The existing communication process has been demonstrably effective in identifying MSD/MED, but there is room to improve

7.1.2 Additional Operator Actions

The operator should make every effort to provide the following information to the OEM or STC holder to help identify and resolve potential MSD/MED issues sooner:

All Cases

- An exact description of the damage, including crack length, location, flight cycles/hours, and condition of structure.
- Diagram of crack orientation.
- Crack specimen from service airplane (damaged structure may be needed for detailed examination), when requested
- Results of follow-up inspections by operator that identify similar problems on other airplanes in the fleet

MSD

- Re-occurring findings of similar problem in fleet
- Findings where inspections accomplished during the initial repair identify additional damage sites
- Adjacent repairs with similar types of damage

MED

- Operator inspection finds damage at multiple locations

7.1.3 Additional OEM Actions

The OEMs will also need to add or improve capabilities in the identification process. Some example areas:

- Review service history files for possible fleet data to find or verify trends
- If only limited fleet data is available, it may be necessary to support with additional near-term analysis to predict or confirm occurrence as an MSD/MED issue (as opposed to incidental or random damage)
- Verify that similar adjacent details are in fact similar in detail and operating at similar stress levels before classifying a single event or single location as MSD or MED.
- Educate OEM Support personnel to potential MSD/MED scenarios.

7.1.4 OEM/Operator Improved Communication Improvements

Operators and OEMs need to institutionalize a more robust communications model to provide the greater detail described above, and ensure potential issues are recognized sooner. In addition to the external communications between the parties, internal processes and communications models will need to be improved. In particular;

- Operators must work to report all findings, not just report the first few findings and then stop reporting additional findings because they are an old subject
- Diligence will be required on the part of the operators to assure that a developing MED problem is not masked by parts replacement at repetitive maintenance visits
- OEMs also need to look at other ways to uncover potential MSD/MED issues, such as spares demand for susceptible details
- Steps need to be taken to raise awareness at operators in maintenance organizations in addition to the few engineering groups involved

7.1.5 Role of the STG

The STGs have proven to be a key resource in the overall effort to improve the structural health and safety of the transport fleet. The STGs can play an ongoing, constructive part in the management of MSD/MED issues. Operator STG members should participate in OEM planning, and assist in the OEM evaluation and management of potential MSD/MED susceptible structure. Some specific suggestions include:

- For all models exceeding 75% DSG the OEM will develop and maintain a current listing of MSD/MED susceptible locations. This listing will be reviewed by the STG and made available to all operators of that model by the OEM customer support organization.
- When appropriate, the STG will recommend that a formal MSD/MED susceptible area inspection program be initiated focusing on the active high time airplanes (over 75% DSG) from each of the models included in tasking. Operators of these airplanes would be requested to provide Fractography specimens from each of the susceptible areas at the next D-Check. OEMs would provide preplanned repairs and/or replacement parts as applicable. Samples would provide flaw or crack distribution data.

- Add notes in SRM and operator-developed standard repairs for maintenance staff to notify Engineering with details of repairs.

7.2 VALUE OF SERVICE DIFFICULTY REPORTS

7.2.1 Evaluation Process

The existing FAA Service Difficulty Reporting database, collected per FAR 121.703, was researched and evaluated by AAWG OEMs and an operator (Delta). The process consisted of down-loading the database from the FAA s website, application of key word query programs keyed to a date range from January 1, 1996 to May 1, 1998, all fuselage entries, and all operator reports for B727, 737, 747, L1011 and DC-9 airplane models. The key word search consisted of identification of all cracked structure in fuselage skins, pressure bulkheads and stringers and/or longerons, as applicable.

7.2.2 Results and Conclusions

Ten percent of fuselage skin crack reports on one model airplane indicated MSD in individual skin panels. None of the individual reports indicated MED cracks in fuselage frames or pressure bulkheads.

The conclusions of the AAWG concerning the effectiveness of SDR data for evaluating the health of the fleet with respect to widespread fatigue damage can be summarized as follows:

- The quality of discrepancies reported on the SDRs required considerable model-specific expertise to understand and analyze the reports

- The report format is not conducive to automated analysis

- SDRs are not timely, often lagging other more direct methods (full scale fatigue tests, operator/OEM repair coordination, AAWG Structures Task Group meetings, etc.) routinely used to identify susceptible areas by significant periods of time.

- The data was not representative of the world-wide fleet

- Cracks reported individually did not make any multiple events apparent without prior knowledge of the reviewer

- There were no new MSD/MED findings, i.e. not already identified by the OEM without service actions already in place

- Some usefulness in providing an indication of frequency of occurrence

Based on this activity, AAWG has concluded that further or ongoing review of SDR data is not a necessary or beneficial process in the identification or resolution of WFD related service problems. Furthermore, much difficulty was experienced in establishing trends from the data.

7.3 AIRPLANE SPECIFIC EVIDENCE OF MSD/MED

7.3.1 Evaluation Process

AAWG members conducted a review of fatigue test and service data to determine the health of the fleet with respect to widespread fatigue damage.

The data collected and summarized consisted of identification of design detail, source of the data, type of problem (MSD/MED) encountered, number of airplanes affected, service action status, service action threshold, and regulatory status.

7.3.2 Results and Conclusions

Limited MSD/MED test or service findings were identified on each model surveyed. (B727, 737, 747, L1011, A300, A310, DC-9, BAe1-11) Susceptible structure consisted of fuselage longitudinal and crown circumferential skin joints, fuselage stringer splices, pressure bulkheads, (rings / web splice and attach angle) shear ties, skin at stringer run-outs, skins and beams, frames in flat fuselage areas, doorskin flat pressure bulkheads, fuselage frames adjacent to doorways, horizontal stabilizer stringer subject to acoustic excitation, window band areas, frames below cargo door cutouts, and wing chordwise splices, cargo door latch spool attachments, wing box drain holes wheel well pressure panel beams.

All A-300 and A-310 MSD/MED problems were identified by test. The remaining fleets were primarily, but not exclusively, identified by service reports.

Service actions have been issued for every finding each service action resulted in the issuance of airworthiness directives to mandate inspections in each case.

7.3.3 Airplane Specific Instances Of MED / MSD

Table 7.3.3.1 Specific Evidence of MSD/MED In-Service or Test

SECTION 5.2 FIGURE No.	DESIGN DETAIL DESCRIPTION	SOURCE OF DATA SERVICE / TEST	MSD OR MED
1	FUSELAGE LONGITUDINAL LAP JOINT	T	MSD
1	FUSELAGE LONGITUDINAL BUTT JOINT	T	MSD
1	FUSELAGE LONGITUDINAL LAP JOINTS	S	MSD
1	FUSELAGE UPPER ROW LAPSPLICE	S	MSD
1	FUSELAGE UPPER ROW LAPSPLICE	S/T	MSD
1	FUSELAGE LOWER ROW LAP SPLICE	S/T	MSD
1	FUSELAGE LOWER ROW LAP SPLICE	S	MSD
1	FUSELAGE LONGITUDINAL SKIN LAPS AND TEAR STRAPS	S/T	MSD
1	FUSELAGE WINDOW BELT LAP SPLICE	S	MSD
2	FUSELAGE STRINGER COUPLING	T	MED
2	FUSELAGE CIRCUMFERENTIAL JOINT	T	MSD
2	FUSELAGE CIRCUMFERENTIAL JOINT	S	MSD
2	FUSELAGE CIRCUMFERENTIAL JOINT	S	MSD
2	FUSELAGE CIRCUMFERENTIAL JOINT	S	MSD
2	AFT PRESSURE BULKHEAD CROWN STRINGER FITTING	S	MED
3	FUSELAGE MILLED RADIUS	T	MSD
4	FRAME FEET (CENTER FUSELAGE)	S	MED
4	FUSE FRAMES CRACKING ADJACENT TO FWD PASSENGER DOORWAY	S	MED
4	FUSELAGE SECT 46 FRAMES	S	MED
4	SECT 43 FRAMES BELOW MAIN DECK CARGO DOOR	S	MED
4	FRAMES BELOW MAIN DECK CARGO DOOR	S	MED
4	FUSELAGE LOWER LOBE FRAMES	S	MED
4	FUSELAGE FRAMES AND FLOOR BEAMS IN FLAT SIDED AREAS	T	MED
4	FUSELAGE AFT UPPER FRAMES	T	MED
4	FUSELAGE AFT LOWER FRAMES	T	MED
4	FRAMES ABOVE PASSENGER WINDOW	S	MED
5	FUSELAGE STRINGER TO FRAME ATTACH	S	MED
6	FUSELAGE SHEAR CLIP END FASTENERS ON SHEAR TIED FRAMES	S	MED

Table 7.3.3.1 Specific Evidence of MSD/MED In-Service or Test Continued

SECTION 5.2 FIGURE No.	DESIGN DETAIL DESCRIPTION	SOURCE OF DATA SERVICE / TEST	MSD OR MED
7	REAR PRESSURE BULKHEAD	T	MSD
7	REAR PRESSURE BULKHEAD ATTACH ANGLES	T	MSD
7	REAR PRESSURE BULKHEAD ATTACH ANGLES	T	MSD
7	AFT PRESSURE DOME OUTER RING AND DOME WEB SPLICES	S	MSD
7	AFT PRESSURE BULKHEAD WEB SPLICE	S	MSD
7	AFT PRESSURE BULKHEAD TEE	S	MSD
7	AFT PRESSURE BULKHEAD CROWN STRINGER FITTING	S	MED
8	CIRCUMFERENTIAL SKIN JOINT AT AFT PRESSURE BULKHEAD	S	MSD
9	FUSELAGE CENTER SECTION SHEAR PLATES	T	MED
9	FUSELAGE CENTER SECTION SHEAR WEB	S	MSD
9	FUSELAGE GANTRIES	S/T	MSD
10	FUSELAGE WINDOW BELT	S	MSD
11	OVERWING FUSELAGE ATTACH	S	MED
11	FUSELAGE OVERWING FRAMES AT FLOOR	S	MED
12	UPPER CARGO DOOR LATCH SPOOL BOLTS	S	MED
13	FUSELAGE DOUBLER RUNOUT BELOW AIRSTAIR DOOR CUTOUT	S	MSD
14	WING TOP SKIN AND STRINGER JOINT AT RIB	S/T	MSD
14	WING-CHORDWISE SPLICES (S.O.B. SPLICE PLATE)	S	MSD
14	WING LOWER PANEL JUNCTION FITTING	T	MSD
15	WING LEADING EDGE RIB	S	MSD
16	WING BOTTOM SKIN STRINGER RUN-OUTS ADJACENT TO RIB	S/T	MED
16	CRACKS IN SPANWISE STRINGERS OF HORIZONTAL STABILIZER	S	MED
16	CENTER WING BOX CROSSING AREAS	T	MED
16	CENTER WING BOX DRAIN HOLES	T	MED

8.0 OVERVIEW OF OEM METHODOLOGIES

8.1 AIRBUS INDUSTRIE

8.1.1 Probabilistic Assessment of Structure Susceptible to MSD/MED

A fatigue endurance test of a structure containing a row of nominally identical fastener holes is analogous to testing a series of simple coupons with a single fastener hole. Each single hole coupon initiates detectable cracking at different times, despite being manufactured to a common procedure; similarly, multiple hole structures will not initiate detectable cracks at the same time at each hole.

It is assumed that the crack initiation time at each site susceptible to fatigue cracking is connected to the probability distribution for fatigue endurance given by testing a large number of single hole coupons. A good estimate of the scatter (*i.e.* the standard deviation) in the fatigue endurance of details representative of the airplane structural feature is therefore fundamental to the MSD/MED assessment. The degree of variability in the manufacturing process originally used in the production of the component determines whether MSD or MED will occur, since poor quality control in manufacture results in isolated rogue flaws and the 'lead crack' scenario of traditional damage tolerance criteria. It may be extremely difficult to establish the appropriate level of scatter for a structural evaluation in an ageing airplane. Unfortunately, a supplemental fatigue endurance test programme may not furnish the required information, since 'new build' test coupons are unlikely to be representative of the original production standard, due to process and material changes over the service life of the airplane. Consequently, the conservative assumption of low scatter in fatigue endurance may have to be adopted in order to induce MSD/MED scenarios within the analysis. The assumption of high scatter suppresses multiple cracking scenarios and encourages isolated lead crack scenarios, and may result in a shorter overall fatigue endurance for a multiple hole structure.

The magnitude of the scatter directly affects the mean of the important outputs from a typical MSD fatigue assessment, *viz.* the period to first detectable crack, the period from detectable cracking to a critical crack scenario, and the overall fatigue endurance of the multiple hole structure. However, where there is any uncertainty in the scatter, a fixed standard deviation based upon the largest known values will always give a conservative analysis of fatigue endurance, although the simulation may not include many MSD/MED scenarios.

8.1.2 Calculation Procedure

- Each potential damage site in the structure (generally two per fastener hole) is allocated a different fatigue endurance, drawn randomly from the overall distribution (lognormal or Weibull) of fatigue lives for the simple coupons.

- The crack growth period is divided into intervals within a time-stepping routine, with the following calculation at each discrete time-step:
  - each damage site is checked for the initiation (or otherwise) of a fatigue crack;
  - the growth of each initiated fatigue crack is estimated through the techniques of linear elastic fracture mechanics; the stress intensity factor solutions account for the interaction of adjacent cracks and fastener holes in a simple compounding process, or through detailed finite element analysis;
  - the link-up of adjacent cracks is included within the crack growth calculation, according to the criterion of touching' crack tip plastic zones.

- The calculation stops at some pre-defined condition, *viz.* growth to a given lead crack size or structural failure according to a residual strength criterion such as the conventional crack resistance curve, or *R-curve*', techniques, with an allowance for crack interaction.

These stages form a single 'Monte Carlo' iteration; the calculation is now repeated many times, but with a different fatigue endurance (randomly allocated) at each potential damage site, such that each individual calculation represents a different damage scenario. The final output is a failure distribution (overall fatigue endurance or residual strength) associated with the multiple hole configuration. The results are generally presented graphically; for example, the overall fatigue endurance for the multiple hole configurations can be plotted against the period to the first detectable crack, as in Figure 8.1.1.

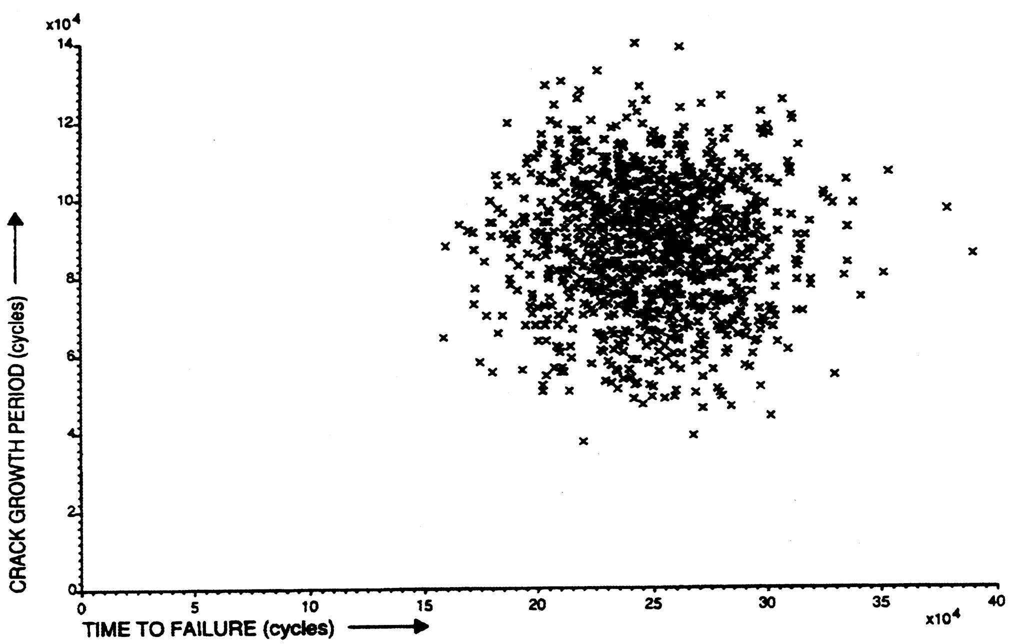


Figure 8.1.1 Fatigue endurance of multiple hole configurations.

The results can also be presented statistically by replacing the individual data points by confidence limits. The reliability of this probabilistic assessment depends on the number of scenarios considered; for example, an accuracy of 1 in 10000 requires the evaluation of at least 10000 scenarios. Figure 8.1.2 shows confidence limits on fatigue endurance for the same multiple hole configuration as in the previous illustration, along with the results of six nominally identical fatigue tests of a representative multiple hole coupon. Although the scatter in the experimental results is high, the data may be seen to be well bounded by the 99% confidence interval.

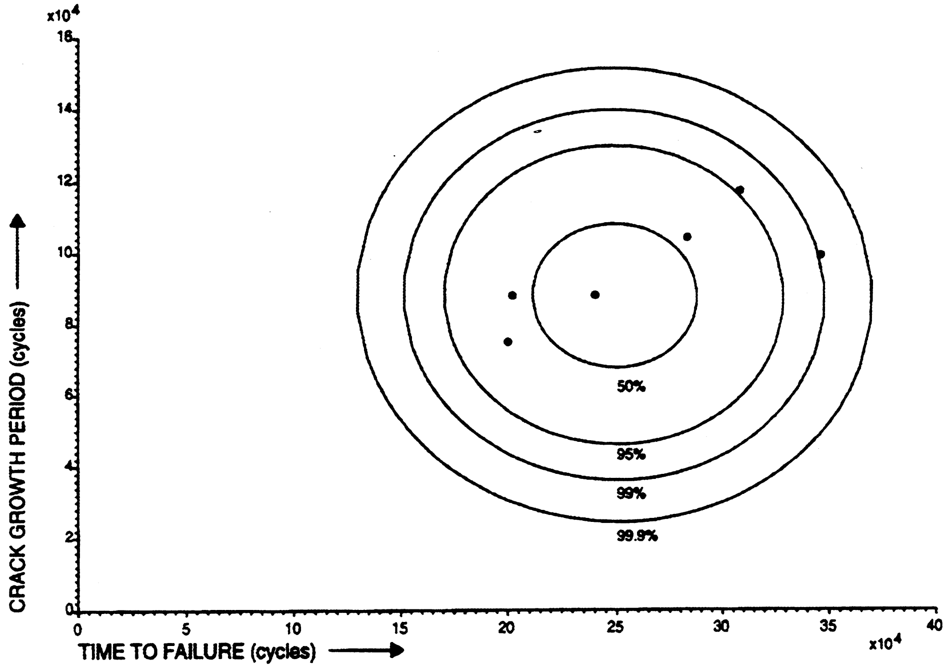


Figure 8.1.2 Confidence limits for multiple hole configurations.

8.1.3 Monitoring Period

In general, the most severe cases of adjacent multiple cracks are likely to develop only after a very long period of fatigue cycling. The most probable scenarios at earlier fatigue lives will be those associated with isolated cracks, for which a damage tolerant inspection and repair strategy should still be possible. However, the increased probability of multiple cracking in an aging airframe should be reflected within the airplane maintenance program, through the introduction of additional directed inspections providing an increased level of surveillance.

If the mean time of occurrence of failure due to WFD is established, either by calculation or test evidence, then a *'Point of WFD'* may be derived (possibly by applying a factor to the mean time for WFD) which represents a lower bound to the mean. Consequently, a *'Monitoring Period'* for operation within the MSD/MED regime may be defined, with the intention of avoiding periods where a damage tolerant inspection strategy may be inadequate because of extensive fatigue cracking. Additional inspections within the Monitoring Period are therefore initiated at some MSD/MED threshold, and continue until the Point of WFD, at which time the airframe must be modified or retired. The repeat inspection interval within the Monitoring Period will clearly be significantly shorter than for normal damage tolerance inspection programmes, in view of the increased risk of structural failure.

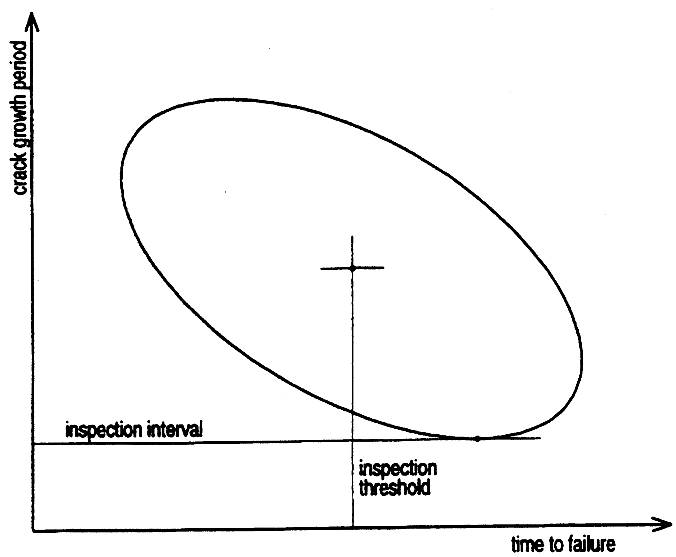


Figure 8.1.3 Inspection threshold & interval from confidence limit.

The basic parameters defining the Monitoring Period — the MSD/MED threshold, the Point of WFD, and the repeat inspection interval — may all be deduced from the results of a probabilistic assessment of structure susceptible to MSD/MED. In Figure 8.1.3, a typical confidence limit from such a calculation is shown, along with the mean time to failure from all of the different scenarios considered. The MSD/MED threshold and the Point of WFD may be established by applying appropriate factors to the mean failure period, whilst the repeat inspection interval is derived from a confidence limit on the crack growth period. A less conservative inspection interval calculation is illustrated in Figure 8.1.4, whereby the interval reduces with increasing airplane life, as a result of the reduced crack growth period in a multiple crack scenario. However, such a variable inspection programme would have to be coincident with airline maintenance schedules.

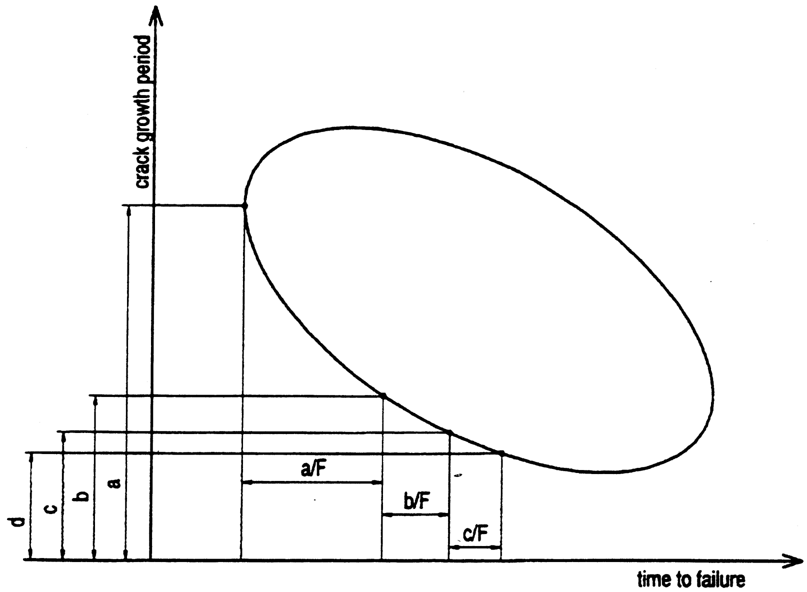


Figure 8.1.4 Modification to inspection interval.

8.2 BOEING COMMERCIAL AIRPLANES

8.2.1 Initiation / Threshold Determination

BCA currently treats MSD/MED initiation the same as MSD/MED detectable. The aim is to achieve an efficient and economical inspection program by starting it when cracks become detectable for a specified inspection method. A MSD/MED initiation with high reliability level is also achieved by focusing on very early cracking in a whole fleet. This reliability is quantifiable because the variabilities of life to cracking at different tiers of aircraft structures have been characterized by extensive testing and decades of operational fleet data. BCA uses the two-parameter Weibull probability distribution, one of the extreme value distributions,

$$F(x) = 1 - \exp\left[-\left(\frac{x}{\beta}\right)^{\alpha}\right];$$

$F(x)$ = Weibull cumulative probability function
x = fatigue life in flights
α = shape or scatter parameter
β = scale parameter or characteristic fatigue life

to model the variabilities at all different structural tiers. In general, BCA considers three structural tiers in WFD analysis, namely, critical detail, WFD component, and airplane. A critical detail, e.g., one or more adjacent rivets where early cracks will occur, is the building block of MSD/MED in a component. A WFD component, e.g., a lap splice, is an assembly of critical details. An airplane usually contains a number of underlying WFD components.

If α_1 and β_1 are the statistics of crack initiation life for critical details in a WFD component, the characteristic life β_2 of WFD component to have r_1% of critical details cracked can be estimated by, letting $x \approx \beta_2$ in the above Weibull distribution,

$$\beta_2 \approx \beta_1 \times \left[-\ln(1 - r_1\%)\right]^{-1/\alpha_1}$$

Similarly, given α_2 and β_2 the statistics of life to damage for same WFD components in an airplane, the characteristic life β_3 of airplane to have r_2% of these WFD components damaged (in r_1% of critical details) can be estimated by

$$\beta_3 \approx \beta_2 \times \left[-\ln(1 - r_2\%)\right]^{-1/\alpha_2}$$

BCA defines the MSD/MED initiation as an very early cracking event, say r_3% of airplanes in a fleet to have r_2% of WFD components damaged in r_1% of critical details, where r_1 usually is around 10 and r_2 & r_3 usually around 1. Thus, the MSD/MED initiation is estimated by the characteristic life β_4 of a fleet to have r_3% of airplanes with the prescribed damage. Let α_3 and β_3 be the statistics of life of airplane in a fleet to the prescribed damage.

MSD/MED Initiation:

$$\begin{aligned}
\beta_4 &\approx \beta_3 \times \left[-\ln(1 - r_3\%)\right]^{-1/\alpha_3} \\
&\approx \beta_1 \times \left[-\ln(1 - r_1\%)\right]^{-1/\alpha_1} \times \left[-\ln(1 - r_2\%)\right]^{-1/\alpha_2} \times \left[-\ln(1 - r_3\%)\right]^{-1/\alpha_3} \\
&\approx \beta_1 \div \prod_{i=1}^{3} \left[-\ln(1 - r_i\%)\right]^{1/\alpha_i} \\
&\approx \beta_1 \div S_{WFD}
\end{aligned}$$

S_{WFD} is a reduction factor applied to the characteristic fatigue life of critical detail to account for variabilities in all structural tiers. The characteristic fatigue life of critical detail is statistically estimated from service/test data provided data are available. Otherwise, analytical methods which involve stress calculation and in-house durability analysis procedures will be used.

The shape or scatter parameter α is estimated based on test/service data. Data over the past twenty plus years have exhibited different α s for different structural tiers. In general, scatter in critical details within a component is smaller than that between components in an airplane, and the scatter between components is smaller than that between airplanes in a fleet. That is, $\alpha_1 > \alpha_2 > \alpha_3$. The following table lists the recommended α values for pressure and externally loaded structures at different structural tiers.

	Pressure Loaded Structure	Externally Loaded Structure
Airplane	5	4
WFD Component	6	5
Critical Detail	8	6

However, different α values may be used if test/service data demonstrate otherwise.

8.2.2 Crack Growth

Crack growth analysis starts with arranging the initial MED/MSD scenario. Initial lead flaw is normally placed in the most likely or stressed detail per stress analysis results or field observation. In the case that equally stressed details exist the lead flaw will be placed in the least inspectable detail for conservatism. Secondary flaws will be placed accordingly around the lead flaw and in the adjacent details.

LEFM theory is used for calculating the growths of multiple flaws simultaneously. Specifically, the Paris law is used in the crack growth calculation with a consideration of spectrum load wherever it is necessary. Average or typical material parameters in the Paris equation are used and crack growth is deterministically calculated.

The stress intensity factors for multiple cracks growth are based on superposition of geometry factors concerning crack interaction and load redistribution. For MSD in collinear rivet holes, e.g., MSD in lap splice, BCA employs a geometry factor that was derived from full-scale lap splice panel tests. This geometry factor is made for a tip-to-tip lead crack with MSD effects considered.

However, when fractography data of actual WFD is available, the empirical crack growth curves may be used.

8.2.3 Residual Strength

BCA uses an empirical knockdown factor for residual strength when MSD is present around a lead crack. In general, it tends to give a conservative result, especially when all cracks are of similar lengths.

At present time, however, BCA only calculates Point of WFD by limiting damage growth to a conservative crack length. For MSD such as lap splice cracking without broken frames, the lead crack is limited to 1 tip-to-tip. For MED such as broken frames without skin cracks, the damage is limited to three broken adjacent frames.

8.2.4 Inspection Programs

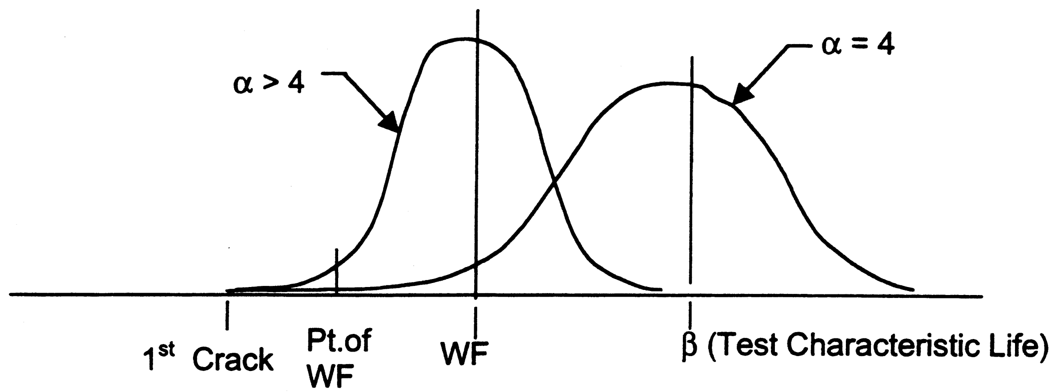
The inspection program will start at the MSD/MED initiation and end at Point of WFD. However, if there are sufficient number of airplanes inspected without evidence of WFD when the fleet leader reaches the end of program, Point of WFD may be justifiably extended.

Inspection methods and frequency will be determined based on BCA s Damage Tolerance Rating (DTR) system. This system will ensure timely detection of any MSD/MED in a fleet with a high probability of detection.

8.3 LOCKHEED-MARTIN AERONAUTICAL SYSTEMS

For the long term, LMAS plans to use available test data and the results of a limited teardown inspection of a retired L-1011 airframe to develop equivalent initial flaw size (EIFS) data. EIFS distributions would be grown forward in time using conventional crack growth methods to predict WFD (either by a Monte Carlo simulation or probability of failure calculations). There is some evidence that recent improvements in the accuracy of small crack growth predictions can produce reliable EIFS distributions, dependent only on the material fastener combination and the crack growth methodology. However, this concept has not been sufficiently validated for 2024-T3 material, and the teardown program is still in the planning stages.

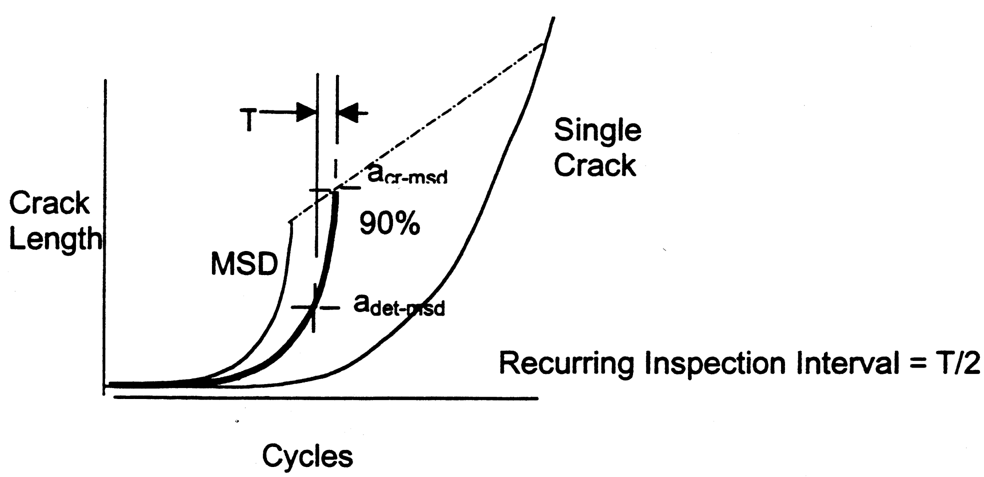
For the near term (until the EIFS concept has been validated), LMAS plans to use analysis based on the results of full scale, component, coupon tests to establish the characteristic time to crack initiation. For airplanes that have operated with stress spectra different from that applied to the test specimens (e.g., due to changes in usage), a test- demonstrated K_t will be calculated from the test results and used with the actual spectrum to estimate the fatigue life. Historical trends regarding the expected scatter in the behavior of the details will be relied upon to estimate the time to first crack and time to threshold or Point of WFD . Currently, there is thought to be some difference in the scatter of structural details within a WFD-susceptible area when compared to non-WFD details. This difference has not been quantified, but the expectation is that within a WFD location, the scatter should be less. Therefore, to be conservative in the estimation of the WFD behavior, the larger scatter factors (based, for example, on a Weibull distribution with a shape parameter, α = 4.0) will be used to calculate the time to first crack from the characteristic life. Then, to estimate the threshold behavior, a reduced scatter (α > 4) will be used to calculate the time from first crack to the Point of WFD, as illustrated in the following sketch.



The time to first crack is the time until there is one crack (of a detectable size) expected to exist in the WFD location.

8.3.1 Crack Growth

In a WFD scenario, with an infinite number of possible configurations of cracks growing simultaneously, there would be a different crack growth curve for each of the configurations. The differences between the crack growth curves are more pronounced as the cracks get larger due to interaction between the adjacent cracks. This, unfortunately, is also the part of the curve used to determine the recurring inspection interval. Two assumptions will represent the upper and lower bounds of the range of possible crack growth curves. As shown in the sketch below, The single crack from a loaded hole with no other active crack tips will represent the slowest growth (least conservative assumption), and the other (most conservative) extreme is when adjacent holes are cracked both sides. A Monte Carlo simulation may be the best way to consider all of the possible curves between these extremes. For the present time, however, LMAS will use an assumption that will maintain simplicity by basing the analysis on a single crack growth curve, which will be more conservative than 90% of all possible curves between the extremes, as indicated in the sketch.



The stress intensity solution for the MSD case (all holes identically cracked) is based on the superposition of correction factors for interacting cracks with the solution for cracks at both sides of a loaded hole.

8.3.2 Residual Strength

The residual strength is based on the link-up of adjacent cracks when the plastic zones touch. The Irwin equation is used to calculate the size of the plastic zones. The accuracy of predicting link-up with the Irwin equation has been shown to be dependent on the crack size and length of the ligament between the crack tips. A function is included with the Irwin model to effectively tune the link-up equation, and force agreement with the results of MSD residual strength tests across the full range of ligament lengths. At the present time, the tuning function has been developed for 2024-T3 aluminum only. Development of similar residual strength data for MSD cracks in 7075-T6 material is recommended.

8.3.3 Inspection Programs

The preliminary action will be to alert operators to areas with WFD potential and request reporting of all service findings. The notification and reporting procedures to be used will be those recommended by the AAWG and implemented by the Structures Working Group. For those areas for which a Monitoring Period is appropriate an inspection program will be developed, terminating modifications will be developed for the other areas. Lockheed may elect to develop modifications which operators may incorporate as an alternate to MSD/MED inspections.

8.4 OVERVIEW OF DELTA AIR LINES METHODOLOGY

The WFD Assessment methodology used by an STC holder may be different than the OEM s because of the lower volume of details to be analyzed. An STC holder has less incentive to develop automated analysis methods or large amounts of material data. Instead, the STC holder will generally use generic software and material data from open sources. However, this reduced volume may also allow an STC holder to use analysis methods that may be more time consuming per detail than an OEM.

The Delta Air Lines approach is a fracture mechanics based methodology, designed to be adapted to a variety of MSD/MED geometries. This approach has been used for safety management in the past for several specific cases, and compares favorable with available OEM data. We also have a large amount of service data from our large and varied fleet (approximately 600 airplanes, with 8 different models, with sub-series) to provide additional validation between our analytical models and actual events.

This methodology overview is tailored for MSD in a lap joint, but it is applicable to any geometry in which MSD is expected in collinear fastener holes.

Note: A comprehensive understanding of fracture mechanics and details of the specific geometry, coupled with fleet reliability data is required to apply this general methodology to a specific case.

8.4.1 Initiation

The Initiation calculation determines the number of cycles required for cracks to reach 0.050 in. length. This calculation is a statistical analysis, based on coupon testing of similar MSD susceptible details. The result of the coupon testing is a characteristic life of the detail.

Based on this characteristic life and an assumed scatter for Al 2024, an Initiation Table of crack initiation times is created. This table lists the cycle intervals after which new cracks will initiate. The number of fastener holes assumed present determines the confidence level of the analysis.

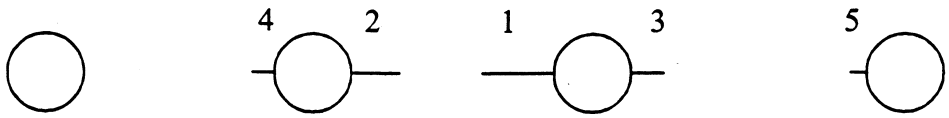
8.4.2 Crack Growth

Crack growth analysis is used to determine MSD crack lengths as a function of airplane cycle, starting from a 0.050 in. flaw. The crack growth analysis assumes a rationally conservative morphology of MSD cracks. It does not necessarily assume the worst case, but rather a cracking sequence which is conservative to some high degree of predetermined confidence.

Multiple cracks are grown using an iterative sequence of FEA models of the component. The initial model contains a single 0.050 in. crack from a hole in a high-stress location.

The succeeding model is the same, except the crack length is incremented one element longer. The stress intensity range is determined empirically by the energy released between models. Then the number of cycles required to reach the succeeding model can be calculated from $da/dN[\Delta K]$ data. Delta typically develops $da/dN[\Delta K]$ from non-proprietary sources such as Mil Handbook 5, or uses the in-house developed software incorporating Modified Forman equation and material data from NASA FLAGRO.

MSD cracks enter the model through the Initiation Table. As total cycle count reaches the next crack s initiation time in the Table, an additional 0.050 in. flaw is introduced into the model. New cracks are continually introduced as the analysis progresses. Each new crack is introduced at the worse location available, so the second crack will be an opposing crack in an adjacent hole. Generally, initiation sites continue outward from the first crack (Crack 1), as shown for five MSD cracks below.



The growth rates of all other cracks are linked to the rate of Crack 1. This linking allows cycle count between successive models to be a function of only the Crack 1 length throughout the analysis.

If MSD crack initiation occurs quickly compared to crack growth, then it is reasonable to simplify the analysis by assuming the worst case, that cracks initiate from both sides of every hole simultaneously. Under this scenario, only one hole must be modeled, with the cracked hole centered within a strip as wide as the fastener spacing. An analytical stress intensity function can be used for this strip model, instead of the FEA sequence empirical function.

8.4.3 Residual Strength

The residual strength criteria is based on the first link-up of two cracks from adjacent fastener holes. The link-up criterion is either the touching of the Irwin plastic zones or the yielding of the ligament between cracks, whichever occurs first. For the FEA empirical analysis, the plastic zones sizes and ligament stresses at limit conditions are checked at each iteration. For the strip model, ligament yield typically occurs first.

8.4.4 Inspection Threshold/Interval Determination

Inspection intervals are based on the detection of individual cracks with a 90% probability of detection, at 95% confidence. The inspection threshold is the time when a crack can first be detected, based on the crack initiation and crack growth to a detectable size. Time to initiation is based on the first cracking in the Initiation Table, factored down to account for variability among components and airplanes within a fleet.

The inspection window, from detectable to critical, is based on crack growth from detectable to the critical condition. The inspection interval is typically equal to this window divided by two, to allow two opportunities for detection.

8.5 ROUND ROBIN EXERCISES

In order to provide some insight for the regulators into the various methodologies presented in the previous section, round robin exercises were developed for the OEMs to try their methods.

Two examples were chosen for each OEM. The first is from the Boeing Company and the second from Airbus Industrie. Each example had been tested and test results were available for comparison to the OEM results. The round robins were done sequentially so that the experience gained from the first example could be applied to the second. Quantitative results are not presented here so that these examples might be used by other entities wishing to validate or confirm alternate analysis methods to their regulators.

Both examples deal with the subject of longitudinal lap splices.

8.5.1 Round-Robin Exercise Number 1

The first example, along with the requisite analysis data is shown in Figure 8.5.1. Airbus, Boeing, Lockheed Martin and Delta Air Lines all calculated the analysis parameters associated with establishing a maintenance program for MSD. All concluded that a Monitoring Period approach was valid for this particular example. Indeed all results derived were conservative with respect to the test results, however there was a significant disparity in the initial results. The AAWG then examined the reasons for the disparity. A total of nine separate areas of analysis were examined to determine where significant differences existed. In was determined that the differences in the results could be attributed to inconsistency in the use of the following parameters.

Key Parameters for MSD / MED Analysis

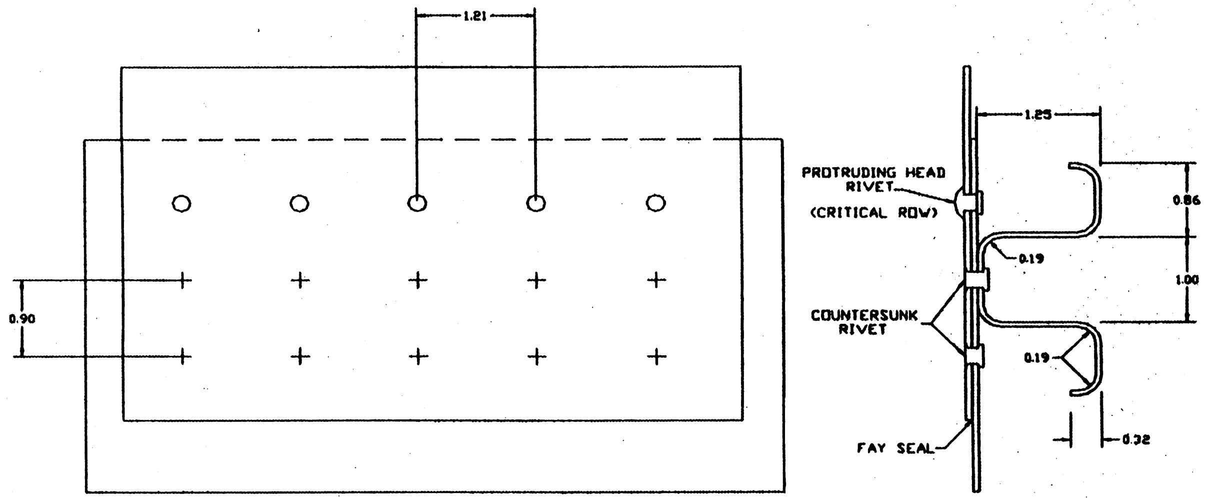
- Flaw size assumed at initiation of crack growth phase of analysis
- Material properties used (static, fatigue, fracture mechanics)
- Ligament failure criteria*
- Crack growth equations used
- Statistics used to evaluate fatigue behavior of the structure (e.g. time to crack initiation)*
- Means of determining Point of WFD*
- Detectable flaw size assumed*
- Initial distribution of flaws
- Factors used to determine lower bound behavior as opposed to mean behavior

Of the nine, the ones marked with an asterisk were considered the most significant in producing results that were different.

8.5.2 Round-Robin Exercise Number 2

The second round robin exercise, Figures 8.5.2 through 8.5.4 was conducted with the first results in mind. A set of ground rules was developed to try and minimize the disparity in the results. These ground rules were determined as shown Figure 8.5.5. In order to do some comparisons, both in-house and specified procedures were requested.

The analysis of the structural detail described in figures 8.5.2 through 8.5.4 was conducted based on coupon test results. The actual detail was tested in a full-scale test and the test results were made available to the participants after the analysis was completed. The results of round-robin number 2 showed fairly good agreement between each of the four OEMs and one airline that participated. The results were not in good comparison to the test however. Further discussion revealed that an additional factor was omitted from the analysis, that being an adjustment between coupon to full scale test. When this factor was applied to the analysis numbers reasonable answers were obtained. Figure 8.5.6 is included to show this effect in a general way. The reader is cautioned that these factors are highly dependent on design configuration, testing protocol, and other factors. A discussion of these scatter factors and mean life tendencies is detailed in section 8.5.3. Coupon to full scale test results could mean a factor on stress of as much as 1.3 or a factor on life of three. These factors have been verified through a number of manufacturer test comparisons.



SKIN
2024-T3 CLAD SHEET
t = 0.063 in
Phosphoric Acid Anodized
Fay Surface Seal

STRINGER
7075-T6 BARE SHEET
t = 0.056 in

PROTRUDING HEAD RIVET
MS20470DD
Hole Size = 0.19 1 - 0.202 in
Diameter = 0.1875 in
Head Size = 0.394 in
Bucked Head Size = 0.2625 in
2017 Aluminum
Hand Driven

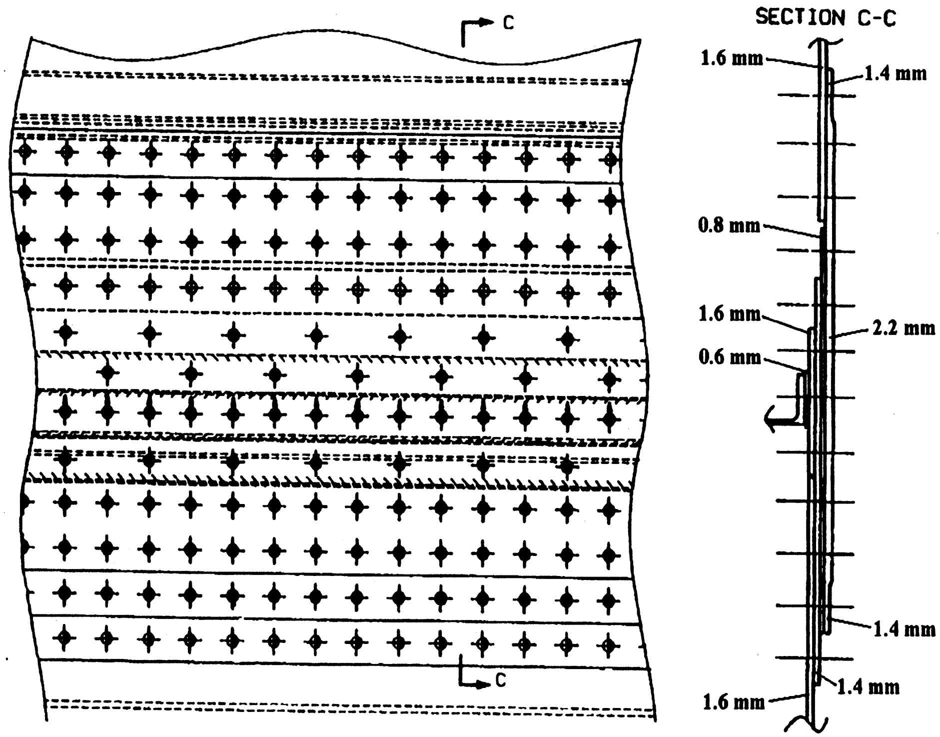
COUNTERSUNK RIVET
NAS1097
Hole Size = 0.190 - 0.196 in
Diameter = 0.1875 in
Head Size = 0.298 in
Bucked Head Size = 0.2625 in
2017 Aluminum
Hand Driven

Airplane Radius = 127 in
Frame Bay Spacing = 20 in
σ = 15 KSI (0.85*pr/t as verified by strain gage stresses at midbay due to load redistribution)
Limit Load Pressure = (Cabin Pressure + Aerodynamic Load)*1.15 = (8.9 + 0.9)*1.15 = 11.3 PSI
Limit Load Case = 0.85*11.3*127/0.063 = 19 KSI

Figure 8.5.1 — Longitudinal Lap Splice Structural Detail — Example 1

AAWG Round Robin

Example Lap Joint Repair



skin material 2024T3
Surface treatment
chromic acid anodizing plus primer
wet assembly and wet riveting
with sealing

Rivet pitch and distance of rivet rows: 24 mm

RIVET	●	NAS1097D06
RIVET	○	NAS1097D05
RIVET	◐	NAS1097D05

Figure 8.5.2 — Lap Joint Repair — Example 2

AAWG Round Robin Exercises
Example 2 – Details

Full scale fatigue test
(fuselage radius 2820 mm)
σ_{max}= 96 MPa in 1.6 mm skin in the center between the frames, R=0 (test stress, circumferential)
limit load stress σ_{limit} = 110 MPa
limit load occurs once per life time
Characteristic life of Critical Detail:
average fatigue life of flat coupon specimens (width 160 mm) up to failure
N = 260000 cycles for σ_a = 48 MPa, R = 0.1
standard deviation: s = 0.19

<u>Skin</u>
2024 T3 clad
t=1.6 mm
Chromic acid anodized
plus primer
wet assembly and wet riveting with sealing
including faying surface
Doubler and shim material 2024T3 clad

<u>Countersunk Rivets in Lap Joint Repair</u>
NAS 1097 DD5 (solution heat treated)
Diameter: 4.0 mm
Head Size: 6.27 mm
Bucked Head Size: 5.6 - 7.5 mm
Material: Al 3.1324T31

NAS 1097 DD6 (solution heat treated)
Diameter: 4.8 mm
Head Size: 7.67 mm
Bucked Head Size: 6.7 - 8.7 mm
Material: Al 3.1324T31

The WFD evaluation is requested for the skin at the run-out of the repair doubler and shims, respectfully.

Skin stress in the center of a frame bay	100 percent
Skin stress at 1/4 length of the frame bay	97 percent
Skin stress at 3/4 length of the frame bay	97 percent
Skin stress close to the frame	89 percent

Figure 8.5.3 — Round Robin Example 2 — Analysis Data

Battelle 2024-T3 tabular data from the Damage Tolerant Design Handbook, Volume 3, page 7.5-94 compiled by UDRI for the USAF and dated December 1983. (For grain orientation: L-T, room temperature lab air environment, R-ratio = 0.0)

The two "endpoints" of this data were fit to the Paris equation to come up with the following:

da/dN = c*deltaK **n
where $c=5.6153*10^{-11}$ and n=4.4323
da/dN = $(5.6153*10^{-11})$*(deltaK**4.4323)

Which yields the following tabular data points (in English units, inch & ksi):

DeltaK	da/dN
0.5	$2.601*10^{-12}$
4.00	$2.6175*10^{-8}$
16.84	$1.53*10^{-5}$
35.36	$4.10*10^{-4}$
100.0	$4.111*10^{-2}$

Figure 8.5.4 — Round Robin Exercise 2 — da/dN Data

Figure 8.5.5 GROUND RULES FOR AAWG-TPG ROUND ROBIN EXERCISE Number 2

The following are the general ground rules to be followed in completing the round-robin exercise.

- Airbus to provide geometry, mean life, standard deviation and other pertinent data by December 14, 1998.
- Each Participant will supply four sets of answers according to the following:

Without Fleet Variability	*With Fleet Variability*
In-house Procedures	In-house Procedures
As Specified Procedures	As Specified Procedures

- Use Mil-Handbook 2024-T3 data.
- Number of defects per airplane = 2
- Number of airplanes in fleet =50 A/P
- For specified procedure use Airbus POD curve with 6mm 95% POD
- For specified procedure assume flaw size at initiation equals 1 mm
- For specified procedure failure criterion is WFD in one frame bay.
- For specified procedure use Paris crack growth law.
- For specified procedure use $WFD_{point}=WFD_{ave}/2.0$
- For specified procedure use Inspection Start Point = $WFD_{ave}/3.0$
- Use in-house procedure for initial damage distribution.

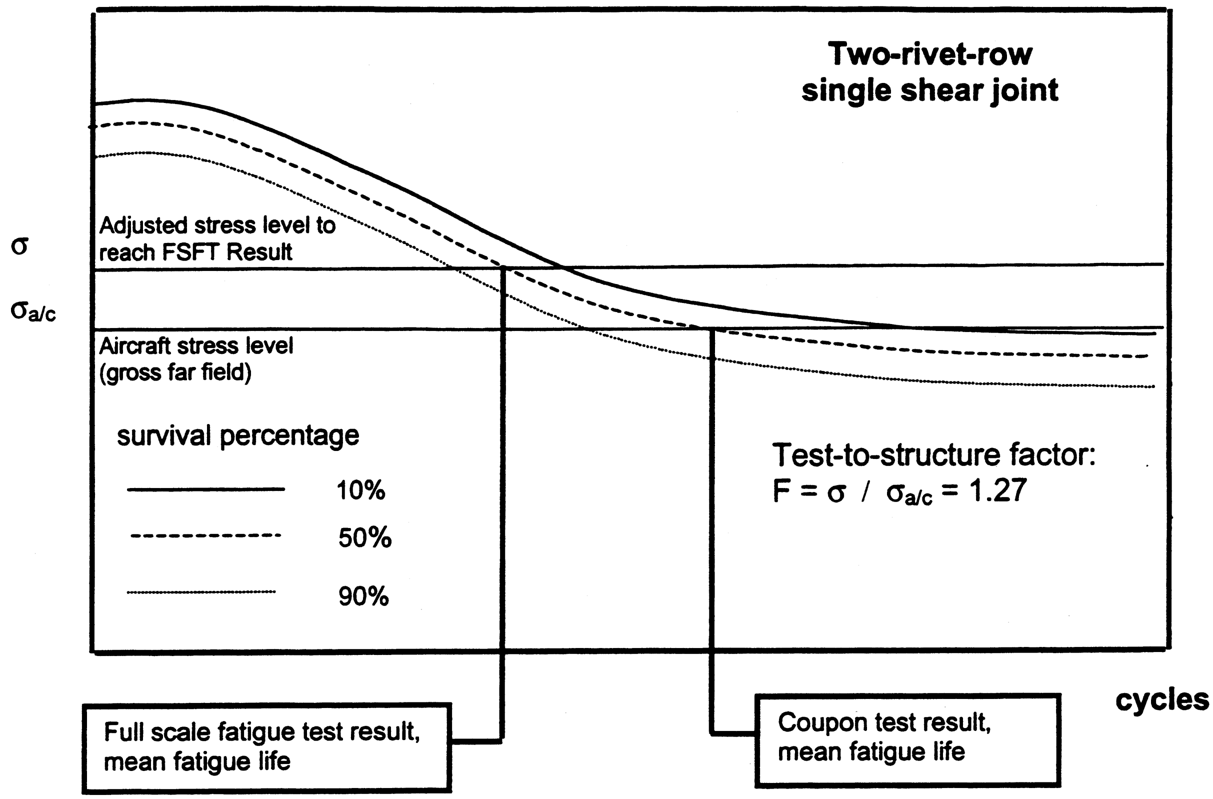


Figure 8.5.6 Typical Coupon Test —To — Full Scale Test Factor

<u>8.5.3 Scatter Factors And Mean Life Tendencies For MSD Crack Initiation</u>

In Appendix A of the 1993 report of the Industry Committee on Widespread Fatigue Damage, the factors to be considered when correlating test data to in-service airplanes were listed, as follows:

1. *<u>Stress spectrum</u> - adjustment may be accomplished using a combination of proven analysis methods and appropriate SN data or by comparative testing.*
2. *<u>Boundary conditions</u> - account for variations of stress levels and distributions at specific locations resulting from unrepresentative boundary conditions or load applications.*
3. *<u>Specimen configuration effects</u> - consideration of the effect of the number or repetitive fatigue sites in a specimen on the average initiation life and scatter band.*
4. *<u>Material aspects</u> - account for differences in material specification and appropriate process treatments.*
5. *<u>Specimen geometry</u> - conditions such as load transfer, type of fastener, secondary bending and pre-stress should represent the actual airplane configuration or be accounted for by an appropriate factor.*

6. *Environmental effects - the effects of environmental conditions should be recognized.*
7. *Scatter - scatter in test results caused by variations in specimens, test conditions and testing techniques (such as cycle rate) should be accounted for.*

Apart from item number 3, each of the considerations detailed in the above list are related to possible differences between a fatigue test specimen (either coupon, component or full-scale) and the actual behavior of the in-service airplane. The central assumption underlying the use of test evidence in predicting airplane structural fatigue is that the experimental results, usually obtained from laboratory tests on simple coupons, are representative of the airframe under service conditions. The aging airplane problem introduces additional concerns as to the validity of this assumption, such as

- For airplane types manufactured over a long period, *e.g.* more than ten years, it is likely that variations will occur in the production procedure and standard, and existing fatigue test evidence may become unrepresentative of the in-service airplane.
- Fatigue test results generated on simple coupons are unlikely to include any useful information on environmental effects such as corrosion, which are central to ensuring the continued airworthiness of the airframe.

It is generally recognized that full-scale fatigue test evidence is more accurate than the results of major component tests or coupons tests in predicting the fatigue endurance and the associated scatter factor for airframe structural components. Coupon or component test specimens are more likely than full-scale test specimens to have manufacturing processes, boundary conditions, and secondary load effects that are unrepresentative of in-service airplanes. The experimental techniques adopted during coupon or components tests, such as the environmental conditions and the cycle rate, may also be significantly different to that experienced by the airplane during operational service.

The third factor in the Industry Committee list was specifically intended to address the effect of an increase in the number of fatigue critical locations (of the same geometry and applied stress spectrum) on fatigue endurance and the associated scatter. Fatigue test results clearly show that first crack initiation occurs sooner in a group of identical repetitive details than in a single detail, provided that everything else (*e.g.* loads, specimen build standards, *etc.*) remains constant. In the case of multiple site damage and multiple element damage, the effects of load redistribution may accentuate this reduction in fatigue life.

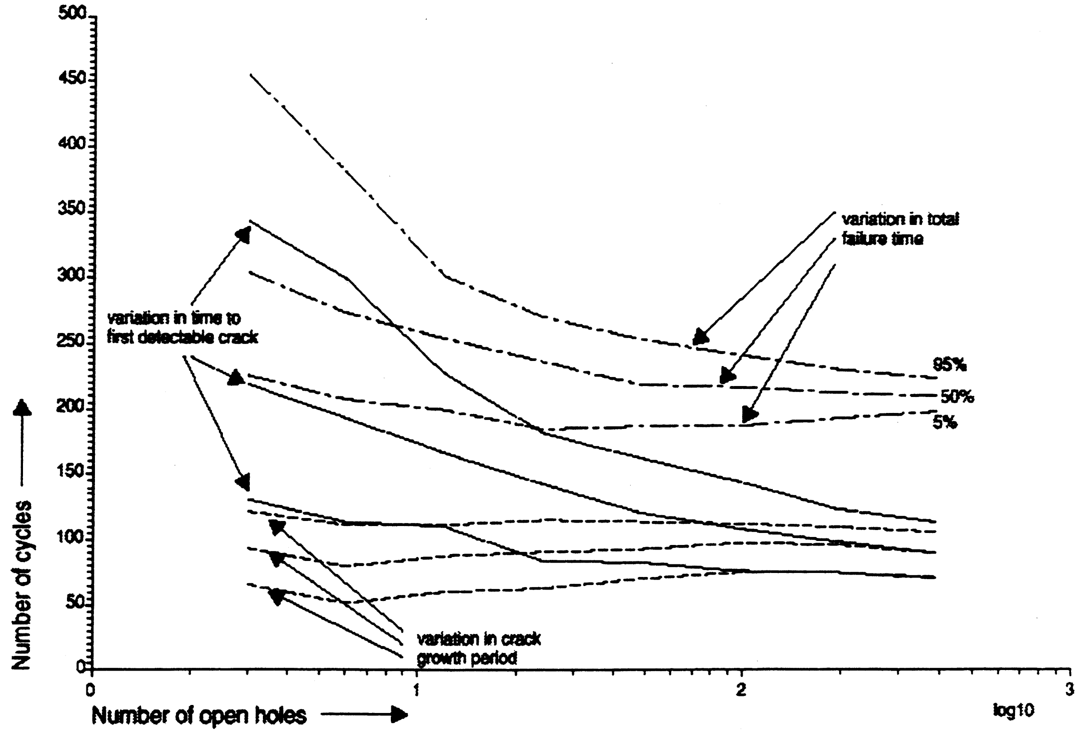


Figure 8.5.3.1 - Statistical analysis of multiple open hole specimen.

The relationship between the probability p_s of fatigue crack initiation at a single site and the probability $p_{1:n}$ of at least one such event occurring within an arbitrary number of sites n may be obtained through a simple order statistics analysis, which gives

$$p_{1:n} = 1 - (1 - p_s)^n \tag{1}$$

This expression is independent of the nature of the probability distribution function used to model p_s (lognormal, Weibull, *etc.*). Hence, given a probability distribution function for p_s, the probability that at least one crack has developed in n potential sites (there are generally two potential sites per hole), at any specified time, may be easily obtained. The mean duration for at least one crack to initiate decreases with increasing n; the scatter in this duration (defined for example by –95% confidence limits) also decreases as n increases. An example of this behavior is shown in Figure 8.5.3.1, which gives the results of a Monte Carlo analysis of a multiple open hole specimen. A significant reduction in the mean time to the development of first detectable crack may be observed as the number of holes increases, along with a parallel reduction in the separation between the 95% confidence limits. In this example, there is not a corresponding decrease in the crack growth period between crack initiation and coupon failure.

It should be noted that the basic input is the probability of a crack initiation event occurring at a single site. If a probability distribution for initiation were defined from tests upon a simple single-hole coupon, for example, there would usually be two equally likely potential sites for crack initiation. Therefore, the distribution for p_s may be readily obtained by applying a correction to the probability distribution for the single-hole coupons, using the above expression with $n=2$. Obviously, a modification of this procedure can be applied to coupons with more than one fastener hole. A more general expression can be derived for at least m initiation events within n potential sites ($m < n$). However, the simple statistical approach breaks down in the presence of crack growth, since additional cracks are rapidly induced by load redistribution. Experience shows that the general expression can be used for $m=2$ or 3 to a reasonable accuracy. The prediction of larger numbers of newly initiated cracks requires a more representative model incorporating both the initiation and the fatigue crack growth stages.

9.0 AIRPLANE SPECIFIC TIMETABLE RECOMMENDATIONS FOR COMPLETION OF AUDIT

9.1 AIRPLANE FLEETS AT RISK

The scope of this WFD structural evaluation has been expanded from the initial eleven (11) Aging Fleet models identified in the AAWG Final Report on Structural Fatigue Evaluation dated October 14, 1993 (Reference [3]). It now includes all large transport category airplanes having a maximum take-off gross weight (MTOGW) greater than 75,000 lbs., which have been certified to pre-or post-Amendment 45 standards.

In order to ensure that the WFD evaluation is completed in a timely manner with respect to the actual service life accumulated to-date, the following fleet selection criterion has been established based on the Design Service Goal (DSG) or the Extended Service Goal (ESG):

WFD Evaluation Priority

Category	Fleet Status	Required Action
A	> 100% DSG or ESG	Expedite WFD program implementation by Dec 31, 2001 See Section 10
B	> 75% DSG or ESG	WFD program development should have begun
C	> 50% DSG or ESG	Initiate preliminary planning for WFD program development

Any fleet status below 50% DSG/ESG does not require action at this time. The number of airplanes in each priority category is documented in Tables 9.1and 9.2, to assist in prioritizing industry action.

These tables list passenger and freighter airplanes in chronological order of certification date, relating to pre- and post-amendment 45 status. However, they exclude Russian and Japanese airplanes and other models having fewer than ten airplanes in commercial service. Values of MTOGW are also integrated into these tables for the respective fleet types as well as the current number of airplanes in service.

Table 9.1 Large Transport Category Airplanes Certified Pre-Amendment 45

AIRPLANE	Initial Certification Information			Number in Service	DSG 1000 LDGS	ESG 1000 LDGS	WFD* Audit Completion Date	Number of Airplanes In Each Category			Models
	CERT DATE	PAX	MTOGW 1000lb.					A >100% D/ESG	B >75% D/ESG	C >50% D/ESG	
L188	Aug-53	74	116	39	N/A	N/A	NP	?	?	?	Electra
B707	Sep-58	174	280	197	20	N/A	12-31-01	110	179	179	-100,-300
DC8	Aug-59	139	276	300	25	70	12-31-01	0	17	103	-10,-20,-30,-40,-50,-50F,-60,-60F,-70, -70F
B720	Jun-60	149	230	11	30	N/A	12-31-01	4	9	10	720,720B
B727	Dec-63	125	161	1525	60	N/A	12-31-01	24	474	1060	-100,-100C,-200,-200F
BAC111	Apr-65	99	104	106	55	85	NP	0	10	43	
DC9	Nov-65	90	79	862	40	100	12-31-01	4	198	600	-10,-10F,-20,-30,-30F,-40,-50
B737	Dec-67	99	98	1021	75	N/A	12-31-01	31	233	528	-100,-200,-200C
F28	Feb-69	55	65	204	60	90	12-31-01	0	13	56	
B747	Dec-69	450	713	1048	20	N/A	12-31-01	96	243	491	-100,-200
DC10	Jul-71	270	430	413	42	N/A	12-31-01	3	52	241	-10,-30,-30F,-40
L1011	Apr-72	400	474	214	36	N/A	12-31-01	4	33	136	-1, -14, -15, -3
A300	Mar-74	345	301	230	48/40/34	N/A	12-31-03	0	13	76	B2, B4-100, B4-200
Concorde	Jan-76	100	407	13	6.7	8.5	NP	0	5	2	
MD80	Aug-80	155	140	1145	50	N/A	NP	0	47	217	-81,-82,-83,-87,-88
B747	Mar 83	450	833	471	20	N/A	NP	0	0	467	-300, -400
B737	Nov 84	159	140	1880	75	N/A	NP	0	0	21	-300, -400, -500
A300#	Jun 86	345	363	213	30	N/A	12-31-03	0	2	16	-600, -600R, -F4-605

- Certified pre Am 45, Analysis to Post Am 45 Standards
* Program ready to be incorporated into operators maintenance programs. Programs currently under development are voluntary OEM Programs.
NP — None Planned at this time

Table 9.2 Large Transport Category Airplanes Certified Post Amendment 45

AIRPLANE	Initial Certification Information			Number in Service	DSG 1000 Ldgs	ESG 1000 Ldgs	WFD Audit Completion Date	Number of Airplanes In Each Category			Models
	CERT DATE	PAX	MTOGW 1000lb.					A >100% D/ESG	B >75% D/ESG	C >50% D/ESG	
B767	Jul-82	210	315	663	50	N/A	NP	0	0	28	-100,-200,-300
B757	Dec-82	185	250	780	50	N/A	NP	0	0	4	
BAe146	Feb 83	90	84	315	50	N/A	NP	0	0	2	
A310	Mar-83	275	291	251	40	N/A	NP	0	0	4	
F100	Nov-87	107	98	276	90	N/A	NP	0	0	0	
A320	Feb-88	150	150	584	48	N/A	NP	0	0	0	
MD11	Jul-90	320	602	167	20	N/A	NP	0	0	0	
A340	Dec-92	440	567	115	20	N/A	NP	0	0	0	
A330	Oct-93	440	467	61	40	N/A	NP	0	0	0	
A321	Dec-93	220	183	75	48	N/A	NP	0	0	0	
MD90	Nov -94	172	156	59	60	N/A	NP	0	0	0	-30
B777	Apr 95	300	650	89	44	N/A	NP	0	0	0	
A319	Apr-96	145	141	45	48	N/A	NP	0	0	0	
Gulfs- V	Apr 97	19	90.5	30	40 FH	N/A	NP	0	0	0	
Bom GE	Aug 98	19	93.5	0	15	N/A	NP	0	0	0	
F70	Oct 94	80	85	15	90	N/A	NP	0	0	0	

NP — None Planned at this time

9.2 LEAD TIME ISSUES FOR TERMINATING ACTIONS

9.2.1 Introduction

During operator presentations to the Authorities Review Team (ART) at Gatwick, England in March 1998, the AAWG was asked to provide additional information to help with the understanding of issues surrounding lead time for modifications (e.g. parts, planning, etc.) that operators need prior to implementing terminating actions.

9.2.2 Discussion

Since a Monitoring Period is an integral element of the AAWG s recommendations for the evaluation and safety management time during which MSD/MED may occur in the fleet, it is important to understand the necessary planning factors that operators will face prior to accomplishing terminating actions.

To illustrate the impact on the operators, a hypothetical narrow-body fuselage lap joint modification scenario will be used. For this case, it is assumed that small MSD cracks have been experienced in high time airplanes during an implemented monitoring period. The operator impact for anticipated terminating action for a scenario such as this, would be approximately 10,000 hours labor, and up to 40 days out-of-service time for each airplane. For a major carrier, with a large fleet of airplanes, the operational impact would be very significant. For one operator s fleet of 74 airplanes, this equates to over 8 years cumulative time to accomplish airplanes at a single airplane rate, which coincides to a typical HMV or D-Check cycle. Any faster accomplishment would place the terminating action out of phase with normal heavy maintenance visits, and would result in a large number of flight cancellations. Flight cancellations would also occur if the work were scheduled at the normal HMV rate, since the elapsed time would be extended approximately two weeks. Since HMV s are usually scheduled in succession, without gaps, a domino effect on flight cancellations occurs once planned down times are interrupted.

Terminating action for typical fuselage lap joints would require the manufacture of long curved panels, used to replace the original joints. The length required for full skin joint replacement may be beyond normal raw stock sizes, and special mill-runs could be required. Special tooling is often required to contour panels within specified tolerances, using manufacturing processes beyond the capability of most operators. Lead times for the manufacture of such parts can easily require 9 to 12 months. Additional preparation involves facilities, work platforms, jacks, contour shoring for airplane jig position support, and training of sheet metal technicians to perform the work (difficult thin sheet riveting). And lastly, since the labor required to perform such a modification could exceed industry capacity, additional technicians (mechanics), inspectors, work schedulers, materiel planners and Liaison Engineers would have to be hired, or alternatively work out-sourced to a mod center. During this planning and implementation period, as many as 20,000 additional flight cycles could accrue on the fleet, which must be accounted for in the WFD estimate. Alternatively, work would have to begin on airplanes well below the identified MSD/MED threshold, to meet proposed compliance times.

One other consideration is validation of the proposed terminating action. In the cited demonstrative case, several repair and modification scenarios are envisioned. Each would require extensive full-scale fatigue testing to avoid future service actions on the part of the operators.

9.2.3 Structures Task Group Process

For the fuselage lap joint example cited to illustrate lead-time issues, the following operator concerns should be addressed through the Structures Task Group operator-OEM advisory process:

- A summary of the fleet data and metallurgical data gathered from typical excised cracks, forwarded by operators to the OEM, should be made available to other operators and FAA
- Crack growth curves for the MSD condition should be made available to the operators and FAA
- Advance copies of any modification service bulletin should be made available to the operators as soon as possible to allow the operator planning process to proceed
- SRM revisions to cover FAA approved repair configuration should be readied
- OEM should provide preformed (contoured and curved) modification parts through a equalitarian distribution process
- Service bulletins should include instructions on the logistics of accomplishing specific repairs (specific shoring recommendations, other structural components that can be removed, what other types of simultaneous maintenance activity can be performed concurrently with the modification)
- Faying sealant with long cure times should be utilized to allow installation time without premature curing/hardening of the sealant
- Specific manufacturing process instructions for forming parts should be provided by the OEM
- Service bulletins for terminating action for airplanes under threshold should also be provided to preclude the potential for more substantial future work
- Specific instructions for door opening interfaces with modification parts should be provide in any service action on fuselage lap joints
- Access/removals of electrical systems such as circuit breaker or instrument panels must also be addressed to allow adequate access to the crown area in the forward fuselage area

- Previously repaired joints must also be dispositioned (damage tolerance evaluation supported by fatigue test)
- Aerodynamic performance penalties associated with the installation of protruding head fasteners and external modification parts entire length of fuselage at multiple joints, and effects on airplane stall measurements and characteristics (if fuselage drag is significant) must also be addressed prior to release of terminating action including these design features
- Compliance recommendations should be quantified for differences in fatigue crack initiation and crack growth between different airplane models, i.e. passenger and freighter models.
- Industry facility and skilled personnel capacity should also be evaluated in determining compliance times.
- Compliance times should also consider existing operator scheduled maintenance visits
- Terminating action plans should include compliance flexibility
- OEM compliance recommendations should be based on actual fleet service data
- Compliance times should be implemented for different zones of the fuselage based on stress severity if applicable to support packaging of work
- Long term durability of the terminating action should accurately replicate service conditions with full scale fatigue test

Special task oriented working committees comprised of the airline representatives and OEM should be utilized to discuss lead time and planning complex issues associated with WFD terminating actions.

9.2.4 Summary

A safety management program example using a hypothetical narrow-body fuselage lap joint MSD/MED problem has been used to illustrate potential lead time and planning issues. It is anticipated that approximately 12 months may be necessary to resolve all planning issues associated with terminating action for such a fleet scenario. Any significant WFD terminating action must allow significant planning time for operators and OEM s to resolve the myriad of anticipated (and typical) problems highlighted in the previous section.

10.0 REGULATORY OPTIONS AND ANALYSIS

This task establishes options that the FAA or other regulators can use to make OEMs, STC holders and operators comply with WFD audits of specific models if voluntary means fail since WFD is an airworthiness concern.

10.1 REGULATORY OPTIONS

Possible regulatory actions identified by the AAWG include the following options:

- Task ARAC to develop FAR 121 Operating Rule and Guidance Advisory Circular
- Issue FAR 25.1529 rule change requiring OEMs to develop new airworthiness limitations for WFD prone design details.
- Issue model specific airworthiness directives to require modification of identified WFD prone design details.
- Issue model specific airworthiness directives to require inspection of identified WFD prone design details.
- Issue FAR 121 Operating Rule to require operators to revise their maintenance programs to include additional Supplemental Structural Inspection Programs.
- Issue model specific airworthiness directive to mandate flight cycle service limitations
- Revoke production certificate of non compliant OEM
- Limit production of spare parts by noncompliant OEM
- Increase OEM liability for the type design.

10.2 RELATIVE MERITS OF EACH OPTION

The advantages and disadvantages of each regulatory option in establishing effective WFD prevention are listed in the Tables 10.1 through 10.10.

Table 10.1 — Relative Merits of Regulatory Options

Task ARAC to develop FAR 121 Operating Rule and Guidance Advisory Circular

Option	**Advantages**	**Disadvantages**
Task ARAC to develop FAR 121 Operating Rule and Guidance Advisory Circular	Rulemaking is more appropriate than AD, if WFD is not an immediate airworthiness concern	Long time to develop, mandate and implement program
	Single rule can cover all affected airplane types Rulemaking process provides firm notice of intentions in time to consider courses of action	Limited technical content without OEM Participation Will not address fleet types or design details of immediate airworthiness concern
	Industry infrastructure (model specific) already exists to develop and implement WFD program with AAWG oversight	Costly to operators (may be necessary for operator to bear entire cost of program development)
		Limited industry technical skills available to develop program without OEM participation
		Limited industry ability to validate program without OEM participation
		Uniform compliance among all global operators questionable
		Variations in program development and implementation between fleet types .

Table 10.2 — Relative Merits of Regulatory Options
Issue airworthiness directives to require modification of WFD prone design details

Option	**Advantages**	**Disadvantages**
Issue airworthiness directives to require modification of WFD prone design details	Not dependent on development of inspection program	Problem not rigorously demonstrated by analysis for each model specific detail resulting in overly conservative thresholds
	Very effective (addresses all design details of concern)	Most costly option to operators
	Global acceptance	Long out-of-service times required to accomplish modifications
	Permanent Fix	Extensive analysis and validation required to identify modifications beyond part replacements
		Arbitrary compliance time without rigorous analysis (may be unconservative) Problems with materials without OEM participation
		Special skill requirements to replace parts to original build standards
		Long lead times on parts and tooling
		Limited modification facilities (industry operating at current capacity)
		Limited shoring and tooling available to put airplanes into jig position for modification
		Extrusions or forgings may be obsolete
		Special fastener and coldworking tool shortages
		Airplanes already beyond DSG

Table 10.3 — Relative Merits of Regulatory Options

Issue FAR 25.1529 revision requiring OEMs to develop new airworthiness limitations for WFD prone design details

Option	Advantages	Disadvantages
Issue FAR 25.1529 revision requiring OEMs to develop new airworthiness limitations for WFD prone design details	Precedence for rulemaking, i.e. existing certification requirement	Dependent on OEM participation
	Requires analysis of individual design details instead of shot-gun approach	Long time to develop, mandate (requires regulatory harmonization) and implement program
	OEM Rule	
	Covers old and new certification programs	Will not address fleet types or design details of immediate airworthiness concern (additional rulemaking required)
	Recertification required beyond fixed service limit	Requires additional rulemaking to address repaired structure
	Applicable to STC s	Options dependent on the development and validation of NDI technology

Table 10.4 — Relative Merits of Regulatory Options

Issue model specific airworthiness directives to require inspection of WFD prone design details

Option	Advantages	Disadvantages
Issue model specific airworthiness directives to require inspection of WFD prone design details	Addresses all design details	Requires development of extensive inspection program (identification of critical flaw sizes and locations) and validation of NDI techniques
	Addresses specific fleets of concern	Limited technical merit without OEM participation
	Rapid implementation	Must be demonstrated airworthiness concern
	Perception of doing something	Assures only short term airworthiness (arbitrary probability of detection leading to missed cracks)
		Doubtful global effectiveness (Large areas to be inspected)
		Conservative inspection intervals necessary without extensive analysis
		Very costly (NDI equipment/schedule disruptions/excessive analysis)
		NDI technology may not be ready
		Specific skills required to apply
		Limited availability of specialized NDI equipment
		No permanent fix
		Unacceptable risk associated by management of MSD/MED with only inspections
		Some design details may not be inspectable (hidden details)

Table 10.5 — Relative Merits of Regulatory Options

Issue a FAR 121 Operating Rule requiring incorporation of new Supplemental Structural Inspections into operators maintenance program

Option	Advantages	Disadvantages
Issue a FAR 121 Operating Rule requiring incorporation of new Supplemental Structural Inspections into operators maintenance program	Rule is more appropriate than airworthiness directive since immediate airworthiness concern has not been demonstrated	Long time to develop, mandate and implement program requiring
	Precedence for SSIPs	Will not address immediate airworthiness concerns
	Covers all concerned fleets with singe rule	Inflexible (slow process to revise rule if needed)
	Existing industry infrastructure (model specific STG s) to develop program with AAWG oversight	Requires OEM participation to develop effective large scale program (many design details)
	Addresses only specific design details shown by analysis to be of WFD concern instead of shot-gun approach	Requires rigorous analysis and data, along with validation
	Operator options to customize program to their mission and maintenance program using program guidelines	Requires FAA PMI oversight for uniform application
	Establishes service limit for noncompliance	Arbitrary compliance time to address the effect of repairs and design changes
		Requires rigorous inspection program and NDI development
		Requires threshold validation
		Does not address design details that cannot be reliably managed with inspections

Table 10.6 — Relative Merits of Regulatory Options
Issue model specific airworthiness directives to mandate operational limitations

Option	Advantages	Disadvantages
Issue model specific airworthiness directives to mandate operational limitations	Can be issued quickly to address immediate airworthiness concern	Effectiveness difficult to determine without analysis
	Could be used to extend service life	Could impact other safety areas (ex. Air Traffic Control)
	Ensures global action	Negative publicity for operator and regulators (Certification deficiency implied)
	Does not rely on inspection of large areas	Limits mission of the airplane

Table 10.7 — Relative Merits of Regulatory Options
Issue model specific airworthiness directive to mandate flight cycle service limitations

Option	Advantages	Disadvantages
Issue model specific airworthiness directive to mandate flight cycle service limitations	Addresses immediate airworthiness concern	Economic disadvantages to operators
	Total safety ensured, if retirement set to right value (flight cycle limit)	Limit must be set to conservative flight cycles without rigorous analysis
	Fleet strategic planning simplified	Safe life may be misconstrued to mean that airplanes are safe without continuing surveillance and assessment
		May result in less maintenance as airplanes approach fixed retirement cycle limit (increase in deferred maintenance)
		Production capacity limits mass replacement of large number of airplanes

Table 10.8 — Relative Merits of Regulatory Options
Revoke production certificate of noncompliant OEM s

Option	Advantages	Disadvantages
Revoke production certificate of noncompliant OEM s	Provides economic incentive to OEM to complete WFD program	Not Effective, if OEM is forced out of business Adverse impact on safety if OEM is out of business Not in public interest Does not improve safety (airplanes of concern still operating) Legal constraints for implementation

Table 10.9 — Relative Merits of Regulatory Options
Limit production of OEM spare parts

Option	Advantages	Disadvantages
Limit production of OEM spare parts	Provides economic incentive to OEM to complete WFD program	Penalizes operators of low utilization airplanes that would not otherwise be affected by WFD program Economic burden to both operators & OEMs Parts would be sourced to other manufacturers raising bogus parts and other quality issues Does not improve safety (airplanes of concern still operating) Legal constraints for implementation

Table 10.10 – Relative Merits of Regulatory Options

Increase OEM liability for the type design

Option	Advantages	Disadvantages
Increase OEM liability for the type design	Economic incentive to OEM to complete WFD program	Not effective, if the OEM is not in business Legal constraints for implementation Does not improve safety (airplanes of concern still operating)

10.3 RANKING OF APPLICABLE OPTIONS

While all of the options considered have some merit in addressing WFD issues, some of the issues were less appropriate since they do not actually address the WFD concern. Specifically the options considering penalties against the OEM and STC Holders have no real influence in whether or not airplanes could be operated with active MSD/MED. For this reason, these options will not be considered further. The remaining options all have some considerable benefit in addressing WFD concerns and are all appropriate considering when and how they could be used. Therefore the recommendations contained herein address a suite of potential actions that regulators could use in addressing WFD concerns. These recommendations are split between short and long term actions.

The proposed regulatory options are grouped into short term and long term options, and ranked by terms of effectiveness to prevent WFD. The options also reflect regulatory actions that may be imposed.

10.3.1 Short Term Actions
(Ranked in order of effectiveness)

- Issue model specific airworthiness directives requiring inspection of design details susceptible to develop MSD/MED.
- Issue model specific airworthiness directives requiring modification or replacement of design details susceptible to develop MSD/MED.
- Issue model specific airworthiness directives establishing operating limitations.
- Issue model specific airworthiness directives establishing flight cycle service limitations.

10.3.2 Long Term Actions
(Ranked in order of effectiveness)

- Issue a FAR 121 Operating Rule and Guidance Advisory Circular for the development of model specific WFD programs.
- Issue FAR 121 Operating Rule requiring operators to revise their maintenance programs to include additional Supplemental Structural Inspection Programs.
- Issue FAR 25.1529 rule change requiring OEMs and STC Holders to develop new airworthiness limitations for WFD prone design details.

10.4 PROPOSAL FOR RULEMAKING

From the list above, a total of eight slightly modified proposals were considered for rulemaking.

- FAR 121 Operation Rule that set flight cycle limits for airplanes on a fleet by fleet basis unless the maintenance program at the operator is amended to include additional instructions for continued airworthiness.
- Revise FAR 25.1529 to include provision to limit the validity of the instructions for continued airworthiness for future certification programs.
- Issue Airworthiness Directives to inspect/modify structure to correct immediate safety concerns as a result of findings under either program above.
- Issue ADs to impose operational limits, where effective, to limit the possibility of failure due to WFD.
- Issue ADs to impose service limits where other remedies are not effective.
- Revoke production certificate of non-compliant OEM and STC Holders.
- Limit production of spare parts by non-compliant OEM and STC Holders.
- Increase OEM and STC Holders liability for the type design.

Of the eight, only the first five were considered appropriate for consideration.

The last three were not responsive to the safety concern and therefore not considered further. Of the first five, all five were considered to address WFD issues. The proposed recommendation for rulemaking is divided between short and long-term remedies.

10.4.1 Long Term Remedies

A new FAR 121 Rule that affects all existing fleets of airplanes. The rule would limit the use of the airplanes on a fleet by fleet basis unless the maintenance program at the operator is amended to include additional instructions for continued airworthiness specifically directed towards prevention and correction of widespread fatigue damage. Maintenance program modifications would include additional inspection requirements as well as references to modification requirements most likely made mandatory via ADs.

Revise FAR 25.1529 to include provision to limit the validity (in terms of flight cycles or flight hours) of the instructions for continued airworthiness. This revision would be applicable to all future certification programs. Before reaching the limit, the maintenance program would need to be re-evaluated for the possible inclusion of additional instructions for continued airworthiness. The additional instructions would be specifically directed towards prevention of widespread fatigue damage.

10.4.2 Short Term Remedies for Airworthiness Concerns

Issue Airworthiness Directives to inspect/modify structure to correct immediate safety concerns as a result of findings under either long-term program.

Issue ADs to impose operational limits, where effective, to limit the possibility of failure due to WFD.

Issue ADs to impose service life limits where other remedies are not effective.

10.4.3 Proposed 121 Rule Details

This proposed rule would be applicable to all existing fleets of airplanes certified to Part 25 or its predecessors. The rule would set a calendar time or flight cycle limit for the airplane type beyond which operation would not be allowed without FAA approved changes being made to the maintenance program for the prevention of WFD. The OEM would produce the FAA Approved changes with the assistance of both the operators and regulators. The maintenance program revisions would clearly state the limits of validity of the changes.

Maintenance program revisions would primarily be increased inspection requirements with any necessary structural modifications being mandated through ADs.

The FAR 121 (New) Rule will require an Advisory Circular.

10.4.4 FAR 25.1529 Rule Revision Details

This rule revision would only be applicable to new certification programs. The rule would require an OEM to declare limits of validity, in terms of flight cycles, for the structural maintenance program as part of the certification process.

Operation of the airplane would be prohibited past the stated limits without FAA Approved Changes to the maintenance program. Required changes to the maintenance program would be developed using an STG process. Program revisions for WFD would be similar to that required by the 121 Rule.

Specific immediate airworthiness concerns would be handled by AD.

The establishment of this rule revision may require an additional 121 rule to make operators comply with the limits established in the OEM maintenance program recommendations.

The FAR 25.1529 (Revised) Rule will require an Advisory Circular.

10.4.5 Proposed Use of Airworthiness Directives

The proposed use of ADs is to handle specific immediate airworthiness concerns. These include but are not limited to:

- To address MSD/MED findings of inspection program implemented under the 121 (New) Rule or 25.1529 (Revised) Rule.
- To impose operational restrictions on airplanes that has exceeded the safe operational limits due to active MSD/MED in the fleet.
- To handle specific non-responsive OEMs in performing the required analysis.

10.5 AAWG PROPOSAL FOR RULEMAKING

The AAWG recommendation for proposed rulemaking consists of the following proposals:

- For Existing FAR Part 25 Transport Category Airplanes - A FAA 121 (New) Rule and/or Part 39 (Amended)
- For New Certification Programs
  - FAA 25.1529 rule revision
  - FAA 121 (New) Rule for Operator Compliance
- FAA AC for Both 121 (New) and 25.1529 (Revised) Rule

Based on this proposed rulemaking Task, The AAWG further proposed language for the Terms of Reference used to initiate the Tasking for the follow-on work. The following was proposed to the Regulators and accepted for use in the Terms:

> *"ARAC is tasked to develop regulations (14 CFR part 25 and part 121 et. al) to ensure that one year after the effective date of the rule (e.g. Dec. 31, 2002), no large transport category airplane (> 75,000 lbs. Gross Take off Weight) may be operated beyond the flight cycle limits to be specified in the regulation unless an Aging Aircraft Program has been incorporated into the operators maintenance program.*
>
> *The regulations and advisory material shall establish the content of the Aging Aircraft Program. This program shall cover the necessary special inspections and modification actions for the prevention of Widespread Fatigue Damage (WFD), Structural Modifications, Supplemental Structural Inspections Programs (SSIP)/Airworthiness Limitations Instructions (ALI), Corrosion Prevention and Control Programs (CPCP) and Structural Repairs. The regulations will also require the establishment of a limit of the validity of the Aging Aircraft Program where additional reviews are necessary for continued operation."*

The full recommendation made by the AAWG to ARAC is shown in Appendix G. This proposal was submitted to ARAC on December 10, 1998. The proposal was accepted.

10.6 ADVANTAGES AND DISADVANTAGES

Develop FAR 121 (New) Operating Rule / FAR 25.1529 (Revised) Rule Requiring Incorporation of New Supplemental Structural Inspections and/or Modification Requirements into Operators Maintenance Program for Prevention of WFD

Advantages	Disadvantages
Establishes service limit for maintenance programs	Service limits may be too conservative.
Covers all concerned fleets with a single new rule and revision to another rule.	Requires excessive time to develop, mandate and Implement, subsequent rule changes are slow. Does not affect all foreign operators. *
Infrastructure exists to develop model specific programs under AAWG (e.g. STG).	Requires OEM participation to develop effective large scale programs
Provides for operator flexibility in establishing programs for their fleets.	Requires uniform application of the rule by Individual FAA PMIs.
Model specific documents published by the OEM can specifically address susceptible structure.	Arbitrary compliance times to address repairs/STC changes.
Rule is most appropriate approach since no immediate airworthiness concern exists.	Does not address immediate airworthiness concern. Immediate concerns should be addressed by AD.

* FAA/JAA must find way to make proposed rules effective to all operators

The operators have the following additional concerns with this regulatory proposal.

- OEM Viability / Participation in Program Development
- Technology for detection of small flaws in large area inspections
- Lead time for parts/support of the OEM
- Largely dependent on PMI for uniform enforcement
- Rule implementation times critical to prevent grounding of airplanes
- Any Additional reporting requirements/infrastructure
- Validation of OEM closing actions

11.0 CONCLUSIONS

The following conclusions were reached as a result of this tasking.

- With respect to the 1993 AAWG Report entitled Structural Fatigue Evaluation for Aging Airplanes
    - That the conclusions and recommendations of the 1993 AAWG Report are still generally applicable.
    - That AC 91-56A, released in April 1998 by the FAA has many inconsistencies in use of terminology and should be corrected.
    - That the list of structure susceptible to MSD/MED from the 1993 AAWG Report has been validated and expanded to include additional examples from industry experience.
    - That interaction of discrete source damage and MSD/MED need not be considered as assessment of total risk is within acceptable limits.
    - That because of the instances of MSD/MED in the fleet and the continued reliance on surveillance types of inspections to discover such damage, rules and advisory material should be developed that would provide specific programs to preclude WFD in the fleet.

- With respect to maintenance programs:
    - That an effective aging airplane program including a Mandatory Modification Program, Corrosion Prevention and Control Program, Repair Assessment Program, and a structural supplemental inspection program (SSID or ALI) is a necessary prerequisite for an effective program for MSD/MED.
    - That as long as there is an effective corrosion prevention and control program, interaction of MSD/MED with environmental degradation is minimized.
    - That the use of a Monitoring Period for the management of potential multiple site damage and multiple element damage (MSD/MED) scenarios in the fleet is possible if MSD/MED cracking is detectable before the structure loses its required residual strength.
    - That any program established to correct MSD or MED in the fleet needs careful consideration for the necessary lead times to develop resources to implement fleet action.

- That there is no universally acceptable or required damage size used for certification compliance.

- With respect to research programs:

    - That additional research into the residual strength behavior of structure with MSD/MED should be conducted to supplement existing database.
    - That the highest potential to achieve the necessary improvements of flaw detectability is seen in the field of semi-automated eddy current systems.

- With respect to the Fleet Health and MSD:

    - That every pre-amendment 45 commercial jet type airplane has had instances of MSD/MED in either test or service.
    - That normal inspections (e.g. maintenance programs plus aging airplane programs) conducted by the airlines using procedures developed by the manufacturer have found numerous instances of MSD/MED in the fleet since 1988.
    - That the value of SDRs in determining the health of the fleet with respect to MSD/MED occurrence is limited.

- With respect to Analytical Assessment of MSD/MED:

    - Sufficient technology exists to complete the audit in a conservative manner.
    - That most OEMs have voluntary WFD audit programs in progress.
    - That damage scenarios involving combinations of MSD and MED must be considered if there is a possibility of interaction.
    - That the AAWG participating manufacturers have developed different but viable means of calculating the necessary parameters to characterize MSD/MED and define appropriate maintenance actions whether it be a monitoring period or structure modification/replacement.
    - That the analysis procedures used to characterize MSD/MED scenarios on airplanes needs careful correlation with test and service evidence.

12.0 RECOMMENDATIONS

The following recommendations are made as a result of this study:

- That the FAA review and make changes to AC 91-56A as delineated in section 4.2.1 and 4.2.2 of this report. These changes are intended to remove ambiguous use of terminology and provide additional guidance for entities performing the structural Audit
- That the FAA fund research detailed in Section 6.0, In addition:
  - Every effort should be made to make data from tests conducted in all research programs available at the earliest possible time before formal reports are issued.
  - Tests currently funded, involving lead crack link-up, should be accomplished as soon as possible to support the first round of audits due in three years.
- That the FAA issue a subsequent tasking to ARAC to develop necessary new and/or revised certification and operational rules with advisory material to make mandatory audit requirements for MSD/MED for all transport category airplanes. This recommendation includes the development of rules and advisory material as detailed in Section 10.0.
  - Existing Transport Category Airplanes - A FAA 121 (New) Rule and/or Part 39 (Amended)
  - New Certification Programs
    - FAA 25.1529 rule revision
    - FAA 121 (New) Rule for Operator Compliance
  - FAA AC for Both 121 (New) and 25.1529 (Revised) Rule
- That WFD audits for nearly all pre-amendment 45 commercial jet airplanes should be completed and OEM documents published by December 31, 2001, with some exceptions. On other commercial jet transports, audits should be completed before the high time airplane reaches their respective design service goals.
- That a SSIP or equivalent program and Repair Assessment Program for Post Amendment 45/Pre Amendment 54 airplane be developed and implemented.
- That any rule published as a result of the subsequent tasking become effective one year after final rule publication.
- That the analysis of STCs to primary structure be held to the same audit requirements (criteria and schedule) as OEM Structure.

Appendix A ARAC TASKING STATEMENT

PAGE: 62 FR 45690 NO. 167 08/28/97

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

Aviation Rulemaking Advisory Committee; Transport Airplane and Engine

Issues—New Task

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice of a new task assignment for the Aviation Rulemaking Advisory Committee (ARAC).

SUMMARY: Notice is given of a new task assigned to and accepted by the Aviation Rulemaking Advisory Committee (ARAC). This notice informs the public of the activities of ARAC.

FOR FURTHER INFORMATION CONTACT: Stewart R. Miller, Manager, Transport Standards Staff, ANM-110, FAA, Transport Airplane Directorate, Aircraft Certification Service, 1601 Lind Ave. SW., Renton, WA 98055-4056, telephone (425) 227-2190, fax (425) 227-1320.

SUPPLEMENTARY INFORMATION:

Background

The FAA has established an Aviation Rulemaking Advisory Committee to provide advice and recommendations to the FA Administrator, through the Associate Administrator for Regulation and Certification, on the full range of the FAA s rulemaking activities with respect to aviation-related issues. This includes obtaining advice and recommendations of the FAA s commitment to harmonize its Federal Aviation Regulations (FAR) and practices with the aviation authorities in Europe and Canada.

One area ARAC deals with is Transport Airplane and Engine Issues. These issues involve the airworthiness standard for transport category airplanes in 14 CFR part 25, 33, and 35 and parallel provisions in 14 CFR parts 121 and 135. The corresponding European airworthiness standards for transport category airplanes are contained in Joint Aviation Requirements (JAR)-25, JAR-E and JAR-P, respectively. The corresponding Canadian Standards are contained in Chapters 525, 533 and 535 respectively.

The Task

This notice is to inform the public that the FAA has asked ARAC to provide advice and recommendation on the following harmonization task:

FAR/JAR 25 Aging Aircraft

1. ARAC is tasked to review the capability of analytical methods and their validation; related research work; relevant full-scale and component fatigue test data; and tear down inspection reports, including fractographic analysis, relative to the detection of widespread fatigue damage (WFD). Since aircraft in the fleet provide important data for determining where and when WFD is occurring in the structure, ARAC will review fractographic data from representative "fleet leader" airplanes. Where sufficient relevant data for certain airplane models does not currently exist, ARAC will recommend how to obtain sufficient data from representative airplanes to determine the extent of WFD in the fleet. The review should take into account the Airworthiness Assurance Harmonization Working Group report "Structural Fatigue Evaluation for Aging Aircraft" dated October 14, 1993, and extend its applicability to all transport category airplanes having a maximum gross weight greater than 75,000 pounds.
2. ARAC will produce time standards for the initiation and completion of model specific programs (relative to the airplane's design service goal) to predict, verify and rectify widespread fatigue damage. ARAC will also recommend action that the Authorities should take if a program, for certain model airplanes, is not initiated and completed prior to those time standards. Actions that ARAC will consider include regulations to require Type Certificate holders to develop WFD programs, modification actions, operational limits, and inspection requirements to assure structural integrity of the airplanes. ARAC will provide a discussion of the relative merits of each option.
3. This task should be completed within 18 months of tasking.

ARAC Acceptance of Task

ARAC has accepted this task and will assign it to a working group. The working group will serve as staff to ARAC to assist ARAC in the analysis of the assigned task. Working group recommendations must be reviewed and approved by ARAC. If ARAC accepts the working group s recommendations, it forwards them to the FAA and ARAC recommendations.

Working Group Activity

The working group is expected to comply with the procedure adopted by ARAC. As part of the procedures, the working group is expected to:

1. Recommend a plan for completion of the task, including rationale, for FAA/JAA approval within six months of publication of this notice.
2. Give a detailed conceptual presentation of the proposed recommendations, prior to proceeding with its work.
3. Provide a status report at each meeting of ARAC held to consider Transport Airplane and Engine Issues.

Participation in the Working Group

The working group will be composed of experts having an interest in the assigned task. A working group member need not be a representative of a member of the full committee.

An individual who has expertise in the subject matter and wishes to become a member of the working group should write to the person listed under the caption FOR FURTHER INFORMATION CONTACT expressing that desire, describing his or her interest in the task, and stating the expertise he or she would bring to the working group. The request will be reviewed by the assistant chair, the assistant executive director, and the working group chair and the individual will be advised whether or not the request can be accommodated.

The Secretary of Transportation has determined that the formation and use of ARAC are necessary and in the public interest in connection with the performance of duties imposed on the FAA by law.

Meetings of ARAC will be open to the public, except as authorized by section 10(d) of the Federal Advisory Committee Act. Meetings of the working group will not be open to the public, except to the extent that individuals with an interest and expertise are selection to participate. No public announcement of working group meetings will be made.

Issued in Washington, DC, on August 21, 1997.

Joseph A. Hawkins,

Executive Director, Aviation Rulemaking Advisory Committee.

[FR Doc. 97-22922 Filed 8-27-97; 8:45 am]

BILLING CODE 4910-13-M

Appendix B ARAC WORKING GROUP ACTIVITY REPORTS

The following pages contain the ARAC Working Group Activity Reports given to status the Tasking Activity during the eighteen months of execution.

WORKING GROUP ACTIVITY REPORT

DATE: NOVEMBER 5, 1997

Aviation Rulemaking Advisory Committee; Transport Airplane and Engines

Assigned to: Airworthiness Assurance Working Group

Task Title: ANM-97-434-A - Task 5: FAR/JAR 25, Aging Aircraft

Task Description:

(1) Review the capability of analytical methods and their validation relative to the detection of widespread fatigue damage (WFD). Review evidence of WFD occurring in the fleet. Recommend means of collection of in-service data where data is missing. Determine extent of WFD in fleet. Extend AAWG Report on Structural Fatigue Evaluation for Aging Aircraft to be inclusive of all large transport category airplanes > 75,000 lb. GW.

(2) Establish time standards for the initiation and completion of model specific programs for prediction, verification and rectification of WFD. Recommend actions for Authorities should action not be forthcoming for certain model airplanes with discussions on the relative merits of each action proposed.

Expected Product(s): A task report including recommendations for FAA action.

Schedule:

	Forecast Completion Date	Actual Completion Date
Concept Approval	10/2/97	10/2/97
Technical Agreement	2/21/98	
ARAC Approval for Drafting	N/A	
ARAC Approval for Economic/Legal Support	N/A	
Recommendation to ARAC	2/21/99	
Recommendation to FAA	3/21/99	

Status: Two meetings held (9/11/97 & 10/16/97) - good progress to identify work packages and schedule issues.

Bottlenecks: None at this time

Next Action: Finish defining tasks and work packages, priorities tasks, develop schedule.

Future Meetings: Next meeting planned Nov. 11-12, in Atlanta. January 15, 1998 in Washington D. C.

WORKING GROUP ACTIVITY REPORT

DATE: February 3, 1997

Aviation Rulemaking Advisory Committee; Transport Airplane and Engines

Assigned to: Airworthiness Assurance Working Group

Task Title: ANM-97-434-A - Task 5: FAR/JAR 25, Aging Aircraft

Task Description:

(1) Review the capability of analytical methods and their validation relative to the detection of widespread fatigue damage (WFD). Review evidence of WFD occurring in the fleet. Recommend means of collection of in-service data where data is missing. Determine extent of WFD in fleet. Extend AAWG Report on Structural Fatigue Evaluation for Aging Aircraft to be inclusive of all large transport category airplanes > 75,000 lb. GW.

(2) Establish time standards for the initiation and completion of model specific programs for prediction, verification and rectification of WFD. Recommend actions for Authorities should action not be forthcoming for certain model airplanes with discussions on the relative merits of each action proposed.

Expected Product(s): A task report including recommendations for FAA action.

Schedule:

	Forecast Completion Date	Actual Completion Date
Concept Approval	10/2/97	10/2/97
Technical Agreement	2/21/98	
ARAC Approval for Drafting	N/A	
ARAC Approval for Economic/Legal Support	N/A	
Recommendation to ARAC	2/21/99	
Recommendation to FAA	3/21/99	

Status: Four meetings held - good progress to date working Task issues everyone is cooperating

Bottlenecks: Issue with definitions on WFD

Next Action: Get Regulatory Approval of Technical Approach

Future Meetings: March 2-5, 1998 Gatwick UK
April 21-23, 1998 Long Beach CA
June 23-25, 1998 Hamburg GR
Aug 27-28, 1998 Williamsburg VA

WORKING GROUP ACTIVITY REPORT

DATE: June 10, 1998

Aviation Rulemaking Advisory Committee; Transport Airplane and Engines

Assigned to: Airworthiness Assurance Working Group

Task Title: ANM-97-434-A - Task 5: FAR/JAR 25, Aging Aircraft

Task Description:

(1) Review the capability of analytical methods and their validation relative to the detection of widespread fatigue damage (WFD). Review evidence of WFD occurring in the fleet. Recommend means of collection of in-service data where data is missing. Determine extent of WFD in fleet. Extend AAWG Report on Structural Fatigue Evaluation for Aging Aircraft to be inclusive of all large transport category airplanes > 75,000 lb. GW.

(2) Establish time standards for the initiation and completion of model specific programs for prediction, verification and rectification of WFD. Recommend actions for Authorities should action not be forthcoming for certain model airplanes with discussions on the relative merits of each action proposed.

Expected Product(s): A task report including recommendations for FAA action.

Schedule:

	Forecast Completion Date	Actual Completion Date
Concept Approval	10/2/97	10/2/97
Technical Agreement	2/21/98	3/5/98
ARAC Approval for Drafting	N/A	
ARAC Approval for Economic/Legal Support	N/A	
Recommendation to ARAC	2/21/99	
Recommendation to FAA	3/21/99	

Status: Six meetings held - Technical agreement on approach reached with Authorities Review Team (ART). Tasks adjusted appropriately. Definitions issue settled. NDI review completed.

Bottlenecks: None at this time except for time itself.

Next Action: Perform OEM Round-Robins on existing WFD methodologies.

Future Meetings: June 23-26, 1998 Hamburg GR.
Aug 27-28, 1998 Williamsburg VA.
Oct 6-8, 1998 Munich GR.

WORKING GROUP ACTIVITY REPORT

DATE: September 16, 1998

Aviation Rulemaking Advisory Committee; Transport Airplane and Engines

Assigned to: Airworthiness Assurance Working Group

Task Title: ANM-97-434-A - Task 5: FAR/JAR 25, Aging Aircraft

Task Description:

(1) Review the capability of analytical methods and their validation relative to the detection of widespread fatigue damage (WFD). Review evidence of WFD occurring in the fleet. Recommend means of collection of in-service data where data is missing. Determine extent of WFD in fleet. Extend AAWG Report on Structural Fatigue Evaluation for Aging Aircraft to be inclusive of all large transport category airplanes > 75,000 lb. GW.

(2) Establish time standards for the initiation and completion of model specific programs for prediction, verification and rectification of WFD. Recommend actions for Authorities should action not be forthcoming for certain model airplanes with discussions on the relative merits of each action proposed.

Expected Product(s): A task report including recommendations for FAA action.

Schedule:

	Forecast Completion Date	Actual Completion Date
Concept Approval	10/2/97	10/2/97
Technical Agreement	2/21/98	3/5/98
ARAC Approval for Drafting	N/A	
ARAC Approval for Economic/Legal Support	N/A	
Recommendation to ARAC	2/21/99	Partial 9/98
Recommendation to FAA	3/21/99	

Status: Eight meetings held — Consensus reached on regulatory approach, technical agreement on Monitoring Period. Industry Round Robin Started

Bottlenecks: None at this time except for time itself.

Next Action: Finish OEM Round Robins on existing WFD methodologies. Write Final Report

Future Meetings: Oct 7-9, 1998 Munich GR.
Dec 1-4, 1998 Seattle WA
Jan 25-29, 1999, Bristol GB.

A REPORT OF THE AAWG
RECOMMENDATIONS FOR REGULATORY ACTION TO PREVENT
WIDESPREAD FATIGUE DAMAGE IN THE COMMERCIAL AIRPLANE FLEET

WORKING GROUP ACTIVITY REPORT

DATE: December 9, 1998

Aviation Rulemaking Advisory Committee; Transport Airplane and Engines

Assigned to: Airworthiness Assurance Working Group

Task Title: ANM-97-434-A - Task 5: FAR/JAR 25, Aging Aircraft

Task Description:

(1) Review the capability of analytical methods and their validation relative to the detection of widespread fatigue damage (WFD). Review evidence of WFD occurring in the fleet. Recommend means of collection of in-service data where data is missing. Determine extent of WFD in fleet. Extend AAWG Report on Structural Fatigue Evaluation for Aging Aircraft to be inclusive of all large transport category airplanes > 75,000 lb. GW.

(2) Establish time standards for the initiation and completion of model specific programs for prediction, verification and rectification of WFD. Recommend actions for Authorities should action not be forthcoming for certain model airplanes with discussions on the relative merits of each action proposed.

Expected Product(s): A task report including recommendations for FAA action.

Schedule:

	Forecast Completion Date	Actual Completion Date
Concept Approval	10/2/97	10/2/97
Technical Agreement	2/21/98	3/5/98
ARAC Approval for Drafting	N/A	
ARAC Approval for Economic/Legal Support	N/A	
Recommendation to ARAC	3/16/99*	Partial 9/98
Recommendation to FAA	6/29/99*	

Status: Ten meetings held, project on schedule for — Consensus reached on all technical issues. TOR Drafted. Final report 60% complete.

Bottlenecks: None at this time.

Next Action: Finish Final Report

Future Meetings: Jan 25-29, 1999, Bristol GB
March 11, 1999, Washington D.C. (AAWG TASK APPROVAL)

* DATES CHANGED TO REFLECT NORMALLY SCHEDULED TAEIG MEETING DATES

Appendix C MEETING VENUES

The following meetings were significant in completing this task.

Issues Group	Working Group	Task Group	ART Review	Meeting Date and Venue
X				August 28, 1997, Washington D. C.
	X			September 16, 1997, Seattle WA. (BCAG)
		X		October 16, 1997, Seattle WA. (BCAG)
X				November 5, 1997, Washington D.C.
		X		November 12-13, 1997, Atlanta GA (Lockheed-Martin)
		X		December 15-16, 1997 Toulouse France (Airbus)
		X		January 13-14, 1998, Washington D.C. (BCAG)
	X			January 15, 1998, Washington D. C. (ATA)
X				February 15, 1998, Long Beach CA (BCAG)
		X	X	March 2-5, 1998 Gatwick UK (CAA-UK/JAA)
		X		April 21-23, 1998 Long Beach CA (BCAG-LBD)
X				June 10, 1998, Washington D. C., (AIA)
		X		June 23-26, 1998 Hamburg Germany (Daimler Benz)
		X		August 26-28, 1998 Hampton VA (BCAG)
	X			September 3, 1998, Williamsburg VA (BCAG)
X				September 16, 1998, Seattle WA (BCAG)
		X		October 7-9, 1998 Munich Germany (IABG/Daimler Benz)
		X		December 1-4, 1998 Seattle WA (BCAG)
X				December 10, 1998, Washington D.C. (AIA)
		X	X	January 25-29, 1999 Filton UK (BAe)
	X			March 11, 1999, Washington D. C. (ATA)
X				March 16-17, 1999, Seattle WA (BCA)

Appendix D ATTENDANCE ROSTERS

		TASK GROUP MEETING										
Name	**Representing**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Dorenda Baker	FAA	X			X	X		X		X	X	
Jean Yves Beaufils	Aerospatiale		X	X	X	X	X	X	X	X	X	
Regis Boetsch	Airbus	X	X	X	X	X	X	X	X	X	X	X
John Bristow	JAA		X		X		X	X	X	X	X	X
Aubrey Carter	Delta A/L	X	X	X	X	X	X	X	X	X	X	X
Richard Collins	BAe			X		X	X	X	X	X	X	X
Dick Cummins	BAe		X	X	X	X						
Amos Hoggard	BCAG-LBD	X	X	X	X	X	X	X	X	X	X	X
Ed Ingram	Lockheed		X	X		X	X	X	X	X	X	X
Brian Johnson	BCAG	X	X	X		X	X				X	
Dave Kuchiran	Continental	X			X	X		X	X		X	X
Doug Marsh	BCAG				X		X	X	X	X	X	X
Roy Mosolf	BCAG	X	X	X	X	X		X	X		X	
Jerry Porter	Lockheed	X	X	X	X	X	X	X	X	X	X	X
Hans Schmidt	Daimler Benz		X		X	X	X	X	X	X	X	X
Dave Steadman	Delta A/L			X	X	X	X	X	X	X	X	X
Paul Toivonen	Lockheed								X	X	X	X
Mark Yerger	FedEx					X		X		X	X	X

Appendix E SUPPLEMENTAL TYPE CERTIFICATES

Summary of Federal Aviation Administration Supplemental Type Certificates

MODIFIED TO INCLUDE ONLY MAJOR STRUCTURAL MODIFICATIONS TO PSE's. LIST IS NOT INCLUSIVE OF ALL STRUCTURAL STCs AND DOES NOT INCLUDE THOSE STCs ACCOMPLISHED ON ONLY ONE AIRPLANE

JANUARY 1998

Airbus Industrie

AIRCRAFT MAKE MODEL & T.C. NO.	STC NO.	DESCRIPTION	ACO	STC HOLDER
A300B4-103, -203; *T.C. A35EU*	ST00445SE	Conversion of passenger airplane to haul cargo on main deck. Amended 8/29/97.	NM-S	Flight Structures, Inc. 4407 172nd Street NE Arlington WA 98223
A310-203 (Basic, Variant 01, and Variant 04); A310-221(Basic, Variant 01, and Variant 04), A310-220 (Variant 01 and Variant 04), A310-222 (Variant 01 and Variant 04); *T.C. A35EU*	ST00100NY	Conversion of Passenger to Freighter configuration by installing a large Main Deck Cargo door, upper deck class "E" cargo compartment, floor reinforcement, and other associated modifications. Amended 6/12/96.	NE-NY	Daimler-Benz Aerospace Airbus Kreetslag 10 PO Box 95 01 09 D-21111 Hamburg Germany

British Aerospace

(See Raytheon Corporate Jets and Jetstream for other British Aerospace models)

AIRCRAFT MAKE MODEL & T.C. NO.	STC NO.	DESCRIPTION	ACO	STC HOLDER
BAe.146-200A; *T.C. A49EU*	SA1970SO	Installation of aft cargo door Reissued 10/17/88.	CE-A	Pemco Aeroplex, Inc. P.O. Box 929 Dothan, AL 36302-0929
BAC 1-11; *T.C. A5EU*	SA1350SW	Installation of center wing tank fuel system. Reissued 5/30/79.	WE	Tiger Air Svc Center Inc 3000 North Clybourn Ave Burbank, CA 91505
BAC 1-11 400 Series equipped with Rolls Royce RB163-25 Spey51-14 engines; *T.C. A5EU*	ST846SO	Increase maximum ramp weight to89,000 lbs., increase maximum take- off weight to 88,500 lbs. and decrease maximum landing weight to 77,200 lbs. Issued 7/1/75.	SO	Bruce Gilman P.O. Box 1372 Vicksburg, MS 39180

BAC 1-11, 200, 400 Series; 401AK, 410AQ, 419EP, 412A/EB; *T.C. A5EU*	SA2813WE	Structural modifications per FAA sealed American Co. top Dwg. BAC1100 necessary to allow operation at the increased takeoff weight of 88,500 lbs. Reissued 3/28/84.	NM	Tigerair, Inc. 1888 Century Park East Los Angeles, CA 90067

BOEING AIRPLANE COMPANY

AIRCRAFT MAKE MODEL & T.C. NO.	STC NO.	DESCRIPTION	ACO	STC HOLDER
707-100B; *T.C. 4A21*	SA984CE-D	Increase maximum zero fuel weight. Issued 9/22/76.	CE	The Boeing Co 3801 South Oliver Wichita, KS 67210
707-100B; *T.C. 4A21*	SA2686SO	Installation of Hush Kits. Issued 1/23/90.	CE-A	Quiet Nacelle Corp. 8000 N.W. 56th St. Miami, FL 33266
707-100B; *T.C. 4A21*	SA3595NM	Modification of the Boeing 707-100B airplanes. Reissued 3/29/96.	NM-L	Omega Aviation Serv. 5/6 Knockbeg Point Shannon Airport Co. Clare Ireland
707-123B; *T.C. 4A21*	SA983CE-D	Cargo door and interior installation non-convertible air freighter. Issued 5/24/76.	CE	The Boeing Co 3801 South Oliver Wichita, KS 67210
707-131; *T.C. 4A21*	SA862CE	Addition of large cargo door in left hand side of fuselage. Issued August 1972.	CE	The Boeing Co 3801 S. Oliver Wichita, KS 67210
707-227; *T.C. 4A21*	SA781SO	Installation of a cargo loading door. Reissued 2/8/96.	CE-A	Pemco Aeroplex, Inc. 1943 50th Street North Birmingham AL 35212
707-300; *T.C. 4A26*	SA5503NM	Installation of a number two left hand entry door. Amended 5/22/92.	WE	Transport Aircraft Technical Services Co. 2977 Radondo Ave., Suite B Long Beach, CA 90806-
707-300B Advanced, -300C; *T.C. 4A26*	SA2685SO	Installation of Hush Kits. Issued 12/22/89.	CE-A	Quiet Nacelle Corp. 8000 N.W. 56th St. Miami, FL 33166
707-300B (Advanced), -300C; *T.C. 4A26*	SA2699NM	Modification of the Boeing Model 707-300B (advanced) and 707-300C airplanes. Reissued 8/14/91.	NM-L	Lucas Aviation Inc. 495 South Fairview Santa Barbara, CA 93117
707-300B (Advanced), 707-300C; *T.C. 4A26*	SA4782NM	Installation of engine hush kits. Issued 11/2/89.	NM	Shannon Engr.Inc. 7675 Perimeter Rd. South, Suite 200 Seattle, WA 98108

707-321; *T.C. 4A26*	SA778CE	Addition of large cargo door in left hand side of fuselage. Issued June 1971.	CE	The Boeing Co 3801 S. Oliver Wichita, KS 67210
707-321, -321B, -321C, -331, -386C; *T.C. 4A26*	ST652SO-D	Installation of P&W JT8D engine and associated structural and fairing pod under L.H. wing between No. 2 engine and fuselage. Reissued 9/7/78.	EA	Pan American World Airways, Inc. JFK Int'l Airport Jamaica, NY 11430
707-323C; *T.C. 4A26*	SA2401WE	Alter type design by installation of Transequip structural igloo assembly P/N 245084 in conjunction with loading systems 65-42625, 65-42630, 65-44166, and 65-34899. Reissued 4/28/93.	NM-L	Air Cargo Equipment 2930 East Maria St Rancho Dominquez, CA 90221
707-331; *T.C. 4A26*	SA854CE-D	60,000 lbs. main deck allowable loading. Issued 12/7/73.	CE	The Boeing Co 3801 South Oliver Wichita, KS 67210
707-387B; *T.C. 4A26*	SA1232CE-D	Installation of large cargo door in left hand side of forward fuselage. Issued 6/10/77.	CE	The Boeing Co 3801 South Oliver Wichita, KS 67210
707-387B; *T.C. 4A26*	SA1233CE-D	Increase maximum zero fuel weight to 96,162 KG Issued 8/31/77.	CE	The Boeing Co 3801 S. Oliver Wichita, KS 67210
720 Series; *T.C. 4A28*	SA848CE-D	Additional overwing escape hatch installation interior configuration 2nd additional overwing escape hatch installation. Issued July 1975.	CE	The Boeing Co 3801 South Oliver Wichita, KS 67210
720B; *T.C. 4A2*	SA2687SO	Installation of Hush Kits. Issued 1/23/90.	CE-A	Quiet Nacelle Corp 8000 N.W. 56th St. Miami, FL 33166
720-023B; *T.C. 4A28*	SA985CE-D	Side cargo door and interior installation. Issued 3/17/77.	CE	The Boeing Co 3801 South Oliver Wichita, KS 67210
720-023B, -030B, 720-047B; *T.C. 4A28*	SA851CE-D	Increase maximum ramp weight to 235,000 lbs. and zero fuel WEight to 156,000 lbs. Amended 11/21/78.	CE	The Boeing Co 3801 South Oliver Wichita, KS 67210
727; *T.C. A3WE*	ST01043AT	Approval of increased operating weights as substantiated by design data listed in SIE master reports. Issued 5/21/96.	CE-A	Structural Integrity Engr 6512 Hollywood Blvd Hollywood FL 33024
727 Series, 727-100 Series; *T.C. A3WE*	SA1368SO	Installation of a cargo door. Amended 8/6/85.	CE-A	Aeronautical Engrs. P.O. Box 661027 Miami, FL 33166
727 Series, 727-100 Series, 727-200 Series; *T.C. A3WE*	SA1797SO	Installation of a cargo door. Amended 4/7/93.	CE-A	Aeronautical Engrs. P.O. Box 661027 Miami, FL 33166

727-46; *T.C. A3WE*	SA847CE-D	Structural and system modification for installation of service door and retractable step. Issued July 1975.	CE	The Boeing Co 3801 South Oliver Wichita, KS 67210
727-100 Series; *T.C. A3WE*	SA1444SO	Installation of a cargo door, cargo interior, and 9G restraint net. Reissued 9/5/90.	CE	Pemco Aeroplex, Inc. P.O. Box 2287 Birmingham, AL 35201
727-100 Series; *T.C. A3WE*	SA1896SO	Installation of a cargo door and associated class "E" cargo compartment. Reissued 2/8/96.	CE-A	Pemco Aeroplex 1943 50th St North Birmingham AL 35212
727-100; *T.C. A3WE*	SA4912NM	Increase in the maximum zero fuel weight. Issued 3/27/90.	NM	Leth and Associates 85 222nd Place SE Redmond, WA 98052
727-100; *T.C. A3WE*	SA5767NM	Increase in zero fuel weight. Issued 10/1/92.	NM-S	The Carstan Corp Aeronautical Engineering Svc. 4600 Kietzke Lane Building F, Suite 155 Reno, NV 89502
727-100; *T.C. A3WE*	SA5768NM	Increase in the maximum taxi and flight WEights. Issued 10/1/92 .	NM-S	The Carstan Corp Aeronautical Engineering Svc. 4600 Kietzke Lane Building F, Suite 155 Reno, NV 89502
727-100; *T.C. A3WE*	SA5769NM	Increase in the maximum taxi and flight weights. Issued 10/1/92 .	NM-S	The Carstan Corp Aeronautical Engineering Svc. 4600 Kietzke Lane Building F, Suite 155 Reno, NV 89502
727-100 (S/N 19183 only); *T.C. A3WE*	ST00782AT	Approval of maximum zero fuel weight increase to 132,000 pounds as substantiated by the design data. Issued 6/8/95.	CE-A	Structural Integrity Engr 6512 Hollywood Blvd Hollywood FL 33024
727-100, -200; *T.C. A3WE* 35201	SA1509SO	Installation of a cargo door. Amended 8/31/95.	CE-A	Pemco Aeroplex, Inc. P.O. Box 2287 Birmingham, AL
727-100, -200; *T.C. A3WE*	SA1767SO	Installation of a cargo door. Amended 2/12/88.	CE-A	Hayes Int'l Corp. P.O. Box 929 Dothan, AL 36302
727-100, -200; *T.C. A3WE*	SA7447SW	727-100 modification from an eight unit load device to a nine unit load device configuration. 727-200 modification from an eleven unit load device to a twelve unit load device. Reissued 8/1/91.	CE-A	Federal Express 3101 Tchulahoma Memphis, TN 38118

727-100, -200; *T.C. A3WE*	SA7681SW	Fuselage access door. Issued 12/7/89.	SW	Dalfort Corp. 7701 Lemmon Ave. Dallas, TX 75209
727-100/-200; *T.C. A3WE*	ST00621AT	Installation of aft engine mount on engines 1 and 3. Issued 12/13/94.	CE-A	Flight Structures, Inc. 18810 59th Avenue NE Arlington WA 98223
727-200 Series; *T.C. A3WE*	ST00015AT	Installation of cargo door, Class "E" cargo compartment interior, cargo handling system and barrier bulkhead. Amended 3/20/96.	CE-A	ATAZ, Inc. P O Box 521477 Miami FL 33125
727-200; *T.C. A3WE*	SA5854NM	Modification of the B727 airplane by installation of cascade thrust reversers, acoustic spacers and acoustic tailpipes. Issued 11/20/92.	NM-L	Aviation Equipment, Inc. 7230 Fulton Avenue North Hollywood, CA 91605
All Models of 727, 727-100, 727C, 727-100C, 727-200, 727-200F; *T.C. A3WE*	SA5938NM	Installation of winglets, associated changes in flap and aileron positions and rigging, and related changes to the navigation beacons. Reissued 3/30/95.	NM-S	Winglet Systems, Inc.
727-200; *T.C. A3WE*	SA5960NM	Increase in maximum zero fuel weight. Issued 5/21/93.	NM-L	The Carstan Corp 111 N. First Street, Suite 301 Burbank, CA 91502
727-200; *T.C. A3WE*	SA4833NM	Installation of engine inlet and exhaust noise attenuation treatment including incorporation of exhaust gas internal mixers and modifications to the engine thrust reversers. Amended 7/25/95.	NM-L	Federal Express Corp. 3101 Tchulahoma Memphis, TN 38228
727-200; *T.C. A3WE*	SA5961NM	Increase in the maximum taxi and flight weights. Issued 5/21/93.	NM-L	The Carstan Corporation 111 N. First St, Suite 301 Burbank, CA 91502
727-200; *T.C. A3WE*	ST00350AT	Installation of engine nacelles with noise suppression modifications. Issued 10/4/93.	CE-A	Federal Express Corp P.O. Box 727 Memphis, TN 38194
727-200; *T.C. A3WE*	ST00076SE	Increase in maximum zero fuel weight to 152,000 lbs. and increase in maximum landing weight up to 161,000 lbs. Amended 7/19/95.	NM-L	Altair Holdings Ltd. 111 N. First Street, Suite 301 Burbank, CA 91502
727-200; *T.C. A3WE*	ST00077SE	Increase in maximum taxi and flight weights to 191,000 and 189,500 lbs. Issued 4/13/94.	NM-L	Altair Holdings Ltd. 111 N First Street, Suite 301 Burbank, CA 91502
727-200; *T.C. A3WE*	ST00094SE-T	Increase in the maximum zero fuel weight. Issued 5/31/94.	NM-S	Leth & Associates 85 222nd Place S.E. Redmond, WA 98052

727-200; *T.C. A3WE*	ST00106SE	Increase in the maximum zero fuel weight to 144,000 lbs. Issued 8/11/94.	NM-SE	Altair Holdings Ltd. 111 N. First Street, Suite 301 Burbank CA 91502
727-200; *T.C. A3WE*	ST00107SE	Increase in the maximum taxi and flight weights up to 183,000 and 182,500 lbs . Issued 8/11/94.	NM-SE	Altair Holdings Ltd. 111 N. First Street, Suite 301 Burbank CA 91502
727-200; *T.C. A3WE*	ST00116SE	Increase in the maximum taxi and flight weights up to 197,700 and 196,000 lbs. Amended 6/14/95.	NM-SE	Altair Holdings Ltd. 111 N First Street, Suite 301 Burbank, CA 91502
727-200; *T.C. A3WE*	ST00117SE	Increase in the maximum zero fuel weight to 155,000 lbs. Amended 10/25/95.	NM-SE	Altair Holdings Ltd. 111 N First Street, Suite 301 Burbank, CA 91502
727-200 (S/N s 21157, 21158, 22476, 22549 only); *T.C. A3WE*	ST00925AT	Approval of increased operating weights as substantiated by the design data listed in SIE No. SIE-28-707. Amended 12/21/95.	CE-A	Structural Integrity Engr 6512 Hollywood Boulevard Hollywood FL 33024
727-200, S/N s 21085, 20997 only; *T.C. A3WE*	ST00926AT	Approval of increased operating weights as substantiated by the design data listed in SIE No. SIE-28-713. Issued 12/5/95.	CE-A	Structural Integrity Engr 6512 Hollywood Boulevard Hollywood FL 33024
727-200 (S/N 21269, 21245 only); *T.C. A3WE*	ST00901AT	Approval of increased operating weights as as substantiated by the design data listed in SIE-28-902. Amended 12/21/95.	CE-A	Structural Integrity Engr 6512 Hollywood Blvd Hollywood FL 33024
727-200 Series; *T.C. A3WE*	ST00106SE	Increase in maximum zero fuel weights to 144,000 lbs., and increase in maximum landing weight to 145,500 lbs. Amended 9/11/97.	NM-S	Altair Holdings, Ltd. 111 N First Street, Suite 301 Burbank CA 91502
727-200 (S/N 19483, 19484, 19486, 19491, 20180, 20184, 20185, 20187, 20995, 20996 19480, 19492, 19481, 19482, 19485, 20191 only); T.C. A3WE	ST00633AT	Approval of maximum zero fuel weight increase from 138,000 pounds to 146,000 pounds. Amended 7/12/95.	CE-A	Structural Integrity Engr 6512 Hollywood Blvd Hollywood FL 33024
727-200, S/N 21930 and 21931 only; *T.C. A3WE*	ST00671AT	Approval of maximum landing weight increase from 160,000 pounds to 164,000 pounds. Issued 3/1/95.	CE-A	Structural Integrity Engr 6512 Hollywood Blvd Hollywood FL 33024
727-200; *T.C. A3WE*	ST00719AT	Approval of increased operating weights. Amended & Reissued 8/28/96.	CE-A	Structural Integrity Engr 9560 Topanga Canyon Bvld Chatsworth, CA 91311

727-200 (S/N 22080 only); *T.C. A3WE*	ST00720AT	Approval of maximum zero fuel weight and maximum landing weight (Flaps 30) increases to 157,500 pounds and 166,000 pounds, respectively. Issued 3/28/95.	CE-A	Structural Integrity Engr 6512 Hollywood Blvd Hollywood FL 33024
727-200 (S/N 20938 only); *T.C. A3WE*	ST00795AT	Approval of maximum zero fuel weight increase (155,000 lbs.) and maximum landing weight increase (164 lbs.). Amended 7/12/95.	CE-A	Pemco Aeroplex, Inc. 1943 50th Street North Birmingham AL 35212
727-200; *T.C. A3WE*	ST00939AT	Approval of increased operating weights as substantiated by the design data listed in SIE Master Report List SIE 28-706, Revision A. Amended 8/28/96.	CE-A	Structural Integrity Engr 9560 Topanga Canyon Blvd Chatsworth, CA 91311
727-200 (S/N 21161 only); *T.C. A3WE*	ST00949AT	Approval of increased operating weights as substantiated by the design data listed in SIE Master Report List SIE-28-717. Issued 1/22/96.	CE-A	Structural Integrity Engr 6512 Hollywod Blvd Hollywood FL 33024
727-200 (S/N s 21327, 21328, 21329, 21330, 21331 only); *T.C. A3WE*	ST01013AT	Approval of increased operating weights as substantiated by the design data listed in SIE report SIE-33-701. Issued 4/15/96.	CE-A	Structural Integrity Engr 6512 Hollywood Blvd Hollywood FL 33024
727-222; *T.C. A3WE*	SA4063WE	Deletion of the pair of excess Type I emergency exits located at station 720 and 15. Issued 11/29/79.	NM-L	United Airlines, Inc. San Francisco Int'l Arpt San Francisco, CA 94128
737-100, -200, -200C Series; *T.C. A16WE*	ST223CH	Installation of a Stage 3 hushkit when powered by P&W JT8D-9 series engines. Amended 5/30/95.	CE-C	AvAero 400 N. Beechgrove Rd. Wilmington, OH 45177
737-100 Series, 737-200 Series; *T.C. A16WE*	ST00287AT	Installation of a cargo door. Issued 7/27/93.	CE-A	Aeronautical Engineers, P.O. Box 661027 Miami, Fl 33166
737-200, S/N's 20549, 22002, 22540; *T.C. A16WE*	ST00604AT	Approval of maximum zero fuel weight increase. Issued 11/18/94.	CE-A	Pemco Aeroplex, Inc. 1943 50th Street North Birmingham, AL 35212
737-200, -300 Series; *T.C. A16WE*	SA2969SO	Installation of a cargo door. Amended 2/17/94.	CE-A	Pemco Aeroplex, Inc. P.O. Box 2287 Birmingham, AL 35201
747-2B5B; *T.C. A20WE*	SA2123CE-D	Conversion of passenger airplane to main deck side cargo door dedicated special freighter. Amended 5/19/92.	CE-W	Boeing Commerical Airplane Group, Wichita Division P.O. Box 7730 Wichita, KS 67277-7730
747-100; *T.C. A20WE*	SA2322SO	Installation of a cargo door. Reissued 8/8/91	CE-A	GATX/Airlog Company P.O. Box 3529 Albany, GA 31706

747-100; *T.C. A20WE*	SA5199NM	Increase maximum zero fuel Weight. Reissued 12/19/91.	NM-S	GATX/Airlog 3303 N. Sheridan Gate 32, Hangar 19 Tulsa, OK. 74115
747-100 Series, 747-200 Series; *T.C. A20WE*	SA976CE-D	Fuselage structure and related modification for cargo. Amended 10/28/77.	CE	The Boeing Wichita Co. 3801 South Oliver Wichita, KS 67210
747-122; *T.C. A20WE*	SA4224NM-D	Structural modification to stretched aft upper deck. Reissued 3/17/95.	NM-L	GATX/Airlog P O Box 3529 Albany GA 31706
747-200; *T.C. A20WE*	SA1767SO	Installation of cargo door. Issued 3/25/85.	CE-A	Hayes International Corp. P.O. Box 929 Dothan, AL 36302
747-200; *T.C. A20WE*	SA5759NM	Increase maximum zero fuel Weight. Amended 4/27/95.	NM-S	Gatx/Airlog Company 3303 N. Sheridan Road Tulsa, OK 74115
747-200B Series; *T.C. A20WE*	SA4227NM-D	Conversion of a passenger airplane to a freighter configuration with a side-cargo door. Reissued 5/3/95.	NM-L	GATX/Airlog P O Box 3529 Albany GA 31706
747-200B; *T.C. A20WE* Motte St.	ST00380SE	Increase in the maximum zero fuel weight to 590,000 lb. Issued 10/31/96.	NM-S	Becontree Holdings Limited La Motte Chambers, La St. Helier, Jersey JE1 1BJ Channel Islands
747-206B; *T.C. A20WE*	SA1442CE-D	Installation of Type I door, left side, upper deck fuselage. Issued 10/25/79.	CE-C	Boeing Wichita Company 3801 South Oliver Wichita, KS 67210
747-237B; *T.C. A20WE*	SA1444CE-D	Installation of type I door (left side, upper deck fuselage) extinsion of upper deck and interior reconfiguration. Issued 7/25/80.	CE	Boeing Military Airplane Company 3801 South Oilver Wichita, KS 67210
747-267B; *T.C. A20WE*	SA2725CE-D	Conversion of passenger airplane to main deck side cargo door dedicated special freighter. Issued 7/30/92.	CE-W	Boeing Commercial Aiplane Group, Wichita Div. P.O. Box 7730 Wichita, KS 67277-7730
747-2D3BC; *T.C. A20WE*	SA2727CE-D	Conversion of a combi airplane to main deck side cargo door dedicated special freighter. Issued 10/14/92.	CE-W	Boeing Commercial Airplane Group, Wichita Division P.O. Box 7730 Wichita, KS 67277-7730

Lockheed Aircraft

AIRCRAFT MAKE MODEL & T.C. NO.	STC NO.	DESCRIPTION	ACO	STC HOLDER
188A; *T.C. 4A22*	SA1064SO	Increase in zero fuel weight from 82,500 lbs. to 90,800 lbs. Issued 4/13/79.	SO	Aeronautical Engrs. Inc. P.O. Box 661087 Miami, FL 33166
188A; *T.C. 4A22*	SA1071SO	Increase in zero fuel weight from 86,000 pounds to 92,340 pounds. Issued 6/14/79.	SO	Aeronautical Engrs. Inc. P.O. Box 661087 Miami, FL 33166
188A; *T.C. 4A22*	SA2536WE	Modification and installation of: aft cargo door; cargo loading and retention system; strengthened floor support structure; increased zero fuel weight to 90,000 pounds; improved avionics and instrumentation. Amended 7/24/75.	WE	Lockheed Acft Svc Co. Burbank, CA 91500
188A, 188C; *T.C. 4A22*	SA533GL	Install a smoke elimination door. Issued 6/16/81.	GL	Zantop Int'l Airlines Inc Detroit - Willow Run Arpt Ypsilanti, MI 48197
188A, 188C; *T.C. 4A22*	ST852SO	Installation of cargo door. Issued 9/25/75.	SO	Aeronautical Engrs. Inc. P.O. Box 480602 Miami, FL 33148
188A, 188C; *T.C. 4A22*	SA1754WE	Installation of cargo doors, cargo floor and other changes. Amended 1/22/74.	WE	Lockheed Acft Svc Co. P.O. Box 33 Ontario Int'l Airport Ontario, CA 91761
188A (S/N 1035 and up), 188C; *T.C. 4A22*	SA2889WE	Conversion of Lockheed Model 188A and 188C into all cargo configuration by installation of cargo door, cargo floor and cargo lining. Amended 8/25/75.	WE	American Jet Ind Inc. 7701 Woodley Avenue Van Nuys, CA 91406
188A (S/N 1035 and up), 188C; *T.C. 4A22*	SA2963WE	Increase maximum zero fuel weight to 90,000 pounds by modifying aircraft. Issued 1/29/75.	WE	American Jet Ind Inc. 7701 Woodley Avenue Van Nuys, CA 91406
188A (S/N 1035 and up), 188C; *T.C. 4A22*	SA3059WE	Maximum landing weight substantiated to 98,102 pounds (from 95,650 pounds). Issued 10/23/75.	WE	American Jet Industries 7701 Woodley Avenue Van Nuys, CA 91406
188A (S/N 1035 and up), 188C; *T.C. 4A22*	SA3098WE	Structural modifications. Issued 10/31/75.	WE	American Jet Industries 7701 Woodley Avenue Van Nuys, CA 91406
188A, 188C; *T.C. 4A22*	SA3152WE	Installation of cargo door only. Issued 4/29/76.	WE	American Jet Ind Inc. 7701 Woodley Avenue Van Nuys, CA 91406
188A (S/N 1035 and up), 188C; *T.C. 4A22*	SA3159WE	Installation of cargo floor and interior. Issued 4/29/76.	WE	American Jet Ind Inc. 7701 Woodley Avenue Van Nuys, CA 91406

188A, 188C; *T.C. 4A22*	SA5502NM	Modification of Lockheed model L-188A/L-188C airplanes. Reissued 3/20/92.	NM-L	Channel Express (Air Serviced) Ltd. Building 470 Bournamouth International Christ Church, Dorset BH236DL United Kingdom
188C; *T.C. 4A22*	SA707EA	Relocation of cabin window right-side from fuselage station 217-236 to fuselage station 333-352. Reissued 3/20/74.	WE	Lockheed Acft Svc Co. P.O. Box 33 Ontario, CA 91761.
188C; *T.C. 4A22*	SA708EA	Installation of opening in fuselage right hand for emergency exit between fuselage station 226 and fuselage station 253.4. Reissued 3/20/74.	WE	Lockheed Acft Svc Co. P.O. Box 33 Ontario, CA 91761
188C; *T.C. 4A22*	SA709EA	Installation of floor structure and miscellaneous modifications. Reissued 3/20/74.	WE	Lockheed Acft Svc Co. P.O. Box 33 Ontario, CA 91761 .
188C; *T.C. 4A22*	SA1081SO	Increase in fuel weight from 86,000 pounds to 92,340 pounds. Amended 7/6/95.	CE-A	Aeronautical Engrs. Inc. 7765 NW 54th Street Miami, FL 33166
188C; *T.C. 4A22*	SA1637WE	Installation of cargo door approximately 80 inches high by 144 inches long in left side of fuselage forebody.	WE	Lockheed Acft Svc Co. P.O. Box 33 Ontario, CA 91764
L-188C; *T.C. 4A22* 0460	SA1833SO	Installation of an aft cargo door and cargo compartment interior. Reissued 8/7/91.	CE-A	Universal Cargo Doors and Services, Inc. P.O. Box 660460 Miami Springs, FL 33166-
L-188C; *T.C. 4A22* 0460	SA1834SO	Installation of a forward cargo door and cargo compartment interior. Reissued 8/7/91.	CE-A	Universal Cargo Doors and Services, Inc. P.O. Box 660460 Miami Springs, FL 33166-
188C; *T.C. 4A22*	SA2694WE	Modification for installation of: nose and wingtip instrumentation boom provisions; research apparatus mounting provisions; dropsonde dispenser; increased breathing oxygen provisions and research electrical system. Issued 5/30/73.	RM	University Corp. for Atmospheric Research P.O. Box 1470 Boulder, CO 80302
188C; *T.C. 4A22*	SA2695WE	Modification for installation of: nose instrumentation boom and wingtip instrumentation boom. Modification per STC SA2694WE is required prior to this modification. Issued 5/30/73.	RM	University Corp. for Atmospheric Research P.O. Box 1470 Boulder, CO 80302

L-1011-1-15; *T.C. A23WE*	SA8011NM	Modification to include provisions only for carriage and launch of Pegasus SIV satellite insertion vehicle (SIV). Reissued 6/22/95.	NM-L	Orbital Sciences Corporation 1301 Skyway Drive Bakersfield, CA 93398
L-1011-385-1; *T.C. A23WE*	SA2108SO	Installation of a forward cargo door. Reissued 9/14/95.	CE-A	Avtec STC AG Dufourstrasse 5. CH4052 Basel Switzerland
L-1011-385-1; *T.C. A23WE*	ST00259AT	Increase maximum takeoff weight to 450,000 lbs. Issued 6/18/93.	CE-A	Argosy International 6101 Blue Lagoon Dr, Ste 440 Miami, FL 33126
L-1011-385-1; *T.C. A23WE*	ST00591AT	Increase maximum takeoff weight to 450,00 lbs. Reissued 12/6/94.	CE-A	Argosy International 6303 Blue Lagoon Dr., Ste 364 Miami FL 33126
L-1011-385-1-15; *T.C. A23WE*	ST00847AT	Installation of main deck cargo door, main deck floor modification/ cargo handling and restraint system, 9g cargo bulkhead, Class E cargo compartment and courier seating (with lavatory/galley storage and crew bunks). Amended 12/20/95.	CE-A	Newport Aeronautical 1785 Sahara, Suite 490 Las Vegas NV 89104
L-1011-385-1-15; *T.C. A23WE*	ST01103AT	Increase in Maximum Design Landing Weight from 368,000 lbs. to 38,000 lbs. Issued 8/5/96.	CE-A	Newport Aeronautical 1785 E. Sahara / Suite 490 Las Vegas, NV 89104

McDonnell Douglas Corporation

AIRCRAFT MAKE MODEL & T.C. NO.	STC NO.	DESCRIPTION	ACO	STC HOLDER
DC-8-21, -31, -32, -33, -41, -42, -43, -51, -52, -53, -55, -61, -62, -63, -71, -72, -73; T.C. 4A25	SA1063SO	Installation of forward cargo door. Amended 7/14/94.	CE-A	Aeronautical Engrs. Inc. 7301 NW 32nd Avenue Miami, FL 33147
DC-8-21; *T.C. 4A25*	SA3869WE	Modifications to permit an increase in maximum allowable zero fuel weight. Issued 2/20/79.	WE	G. S. Rasmussen P. O. Box 10519 Glendale, CA 91209
DC-8-21 (S/N's 45422-45427, 45429-45431, 45433-45437 only), DC-8-32, -33, 51 (S/N 45648 only); *T.C. 4A25*	SA421NW	Removal of passenger confirmation interior items and installation of a cargo door on the forward left hand side of the fuselage, cargo restraint bulkhead at station 300, heavy duty flooring, class "E" cargo compartment, and provisions for two (2) additional crew members. Reissued 6/28/88.	CE-A	Rosenbalm Aviation, Inc. (RAI) P.O. Box 10136 Macon, GA 31297
DC-8-21, -31, -32, -51, -52, -53, -55, -61, -62, -63; T.C. 4A25	SA1862SO	Installation of a cargo door. Amended 5/4/94.	CE-A	Agro Air Associates, Inc. P.O. Box 524236 Miami, FL 33152
DC-8-33, S/N's 45261, 45377, 45388, 45421, 45626 only; *T.C. 4A25*	SA260NW	Removal of passenger configuration interior items and installation of a cargo door on the forward left hand side of the fuselage, cargo restraint bulkhead at Station 300, heavy-duty flooring, Class "E" cargo compartment, and provisions for two (2) additional crew members. Reissued 2/9/89.	NW	Rosenbalm Aviation P.O. Box 1524 Medford, OR 97501
DC-8-33; *T.C. 4A25*	SA3403WE	Conversion of passenger airplane to cargo only configuration by installation of cargo door, cargo handling system, and increasing maximum landing and zero fuel weight. Amended 6/14/78.	WE	McDonnell Douglas Corp. 3855 Lakewood Blvd Long Beach, CA 90846
DC-8-33; *T.C. 4A25*	SA3611WE	Modification to permit increase in maximum allowable zero fuel weight. Issued 3/27/78.	WE	G.S. Rasmussen P.O. Box 2052 Glendale, CA 91209
DC-8-33; *T.C. 4A25*	SA3804WE	Modifications to permit an increase in maximum allowable zero fuel weight. Issued 12/13/78.	WE	G.S. Rasmussen P.O. Box 10519 Glendale, CA 91209

DC-8-33; *T.C. 4A25*	SA3907WE	Modifications to permit an increase in maximum allowable zero fuel weight. Issued 4/20/78.	WE	G.S. Rasmussen P.O. Box 10519 Glendale, CA 91209
DC-8-33; *T.C. 4A25*	SA3910WE	Modifications to permit an increase in maximum allowable zero fuel weight.	WE	G.S. Rasmussen P.O. Box 10519 Glendale, CA 91209
DC-8-33, -43, 61F, 62F, 63F, 71F, 72F, 73F, DC-8F-54, -55; *T.C. 4A25*	SA1703GL	Modify existing cargo door assembly by incorporating a window doubler assembly thereby converting cargo door from a no window configuration to a configuration having one window. Issued 2/2/192.	CE-C	National Aircraft Service, 4332 Macon Road Tecumseh, MI 49286
DC-8-43; *T.C. 4A25*	SA3612WE	Modifications to permit increase in maximum allowable zero fuel weight. Issued 3/27/78.	WE	G.S. Rasmussen P.O. Box 2052 Glendale, CA 91209
DC-8-43; *T.C. 4A25*	SA3749WE	Conversion of passenger airplane to cargo only configuration by installation of cargo door, cargo floor, and increasing maximum landing and zero fuel weight. Issued 9/28/78.	WE	McDonnell Douglas Corp. 3855 Lakewood Blvd Long Beach, CA 90846
DC-8-43; *T.C. 4A25*	SA3805WE	Modifications to permit an increase in maximum allowable zero fuel weight. Issued 12/26/78.	WE	G.S. Rasmussen P.O. Box 10519 Glendale, CA 91209
DC-8-43; *T.C. 4A25*	SA3880WE	Modifications to permit an increase in maximum allowable zero fuel weight. Issued 3/28/79.	WE	G.S. Rasmussen P.O. Box 10519 Glendale, CA 91209
DC-8-43; *T.C. 4A25*	SA3911WE	Modifications to permit an increase in maximum allowable zero fuel weight. Issued 4/23/79.	WE	G.S. Rasmussen P.O. Box 10519 Glendale, CA 91209
DC-8-51; *T.C. 4A25*	SA4078WE	Modifications to permit an increase in maximum allowable zero fuel weight. Issued 2/6/80.	WE	G. S. Rasmussen P.O. Box 10519 Glendale, CA 91209
DC-8-51; *T.C. 4A25*	SA4080WE	Modifications to permit an increase in maximum allowable zero fuel weight. Issued 8/21/80.	WE	G.S. Rasmussen P.O. Box 10519 Glendale, CA 91209
DC-8-51, S/N 45855 only; *T.C. 4A25*	ST00543AT	Increase in aircraft operating weights (Maximum takeoff weight - 315,000 lbs., maximum landing weight - 217,000 lbs., maximum zero fuel weight - 203,000 lbs.) Issued 7/20/94.	CE-A	Aircraft Modification Design 8960 Ridgemond Drive Atlanta, GA 30350
DC-8-51, S/N 45410 only; *T.C. 4A25*	ST00558AT	Increase in aircraft operating weights (Maximum takeoff weight - 315,000 lbs., maximum landing weight - 217,000 lbs., maximum zero fuel weight - 203,000 lbs.) Issued 8/26/94.	CE-A	Aircraft Modification Design Svcs 8960 Ridgemont Drive Atlanta, GA 30350

DC-8-51, S/N 45935 only; *T.C. 4A25*	ST00617AT	Increase in aircraft operating weights (maximum takeoff weight - 315,000 lbs., maximum landing weight - 217,000 lbs., maximum zero fuel weight - 203,000 lbs. Issued 12/14/94.	CE-A	Aircraft Mod Design Svcs 8960 Ridgemond Drive Atlanta, GA 30350
DC-8-51, -52, -53, -8F-54, -55, -8-55, -61, -61F; T.C. 4A25	SA2106SO	Installation of a hush kit. Amended 11/9/87.	CE-C	Quiet Nacelle Corporation 8000 N.W. 56th Street Miami, FL 33166
DC-8-51, -52, -53, 8F-54, 8F-55, -55, -61; T.C. 4A25	SA2411SO	Installation of hush kit. Amended 3/23/90.	CE-A	Quiet Nacelle Corporation 8000 N.W. 56th Street Miami, FL 33166
DC-8-53; *T.C. 4A25*	SA3613WE	Modifications to permit increase in maximum allowable zero fuel weight. Issued 3/27/78/	WE	G.S. Rasmussen P.O. Box 2052 Glendale, CA 91209
DC-8-53; *T.C. 4A25*	SA3806WE	Modifications to permit an increase in maximum allowable zero fuel weight. Issued 12/26/78.	WE	G.S. Rasmussen P.O. Box 10519 Glendale, CA 91209
DC-8-53; *T.C. 4A25*	SA3908WE	Modifications to permit an increase in maximum allowable zero fuel weight. Issued 4/20/79.	WE	G.S. Rasmussen P.O. Box 10519 Glendale, CA 91209
DC-8-53; *T.C. 4A25*	SA3909WE	Modifications to permit an increase in maximum allowable zero fuel weight. Issued 4/20/79.	WE	G.S. Rasmussen P.O. Box 10519 Glendale, CA 91209
DC-8-53; *T.C. 4A25*	SA3912WE	Modifications to permit an increase in maximum allowable zero fuel weight. Issued 4/23/79.	WE	G.S. Rasmussen P.O. Box 10519 Glendale, CA 91209
DC-8F-54, S/N 45637 only; *T.C. 4A25*	ST00924AT	Increase in aircraft operating weights (maximum landing weight - 240,000 lbs., maximum zero fuel weight - 224,000 lbs.) Issued 12/4/95.	CE-A	Aircraft Modification Design Services, Inc. 8960 Ridgemont Drive Atlanta GA 30350
DC-8F-54 (S/N's 45802, 45886, 46012 only); *T.C. 4A25*	ST00850AT	Increase in aircraft operating weights as substantiated by the design data. Amended 9/17/96.	CE-A	Aircraft Modification Design Services, Inc. 8960 Ridgemont Drive Atlanta GA 30350
DC-8-61; *T.C. 4A25*	SA4091WE	Deletion of a pair of excess Type 1 exits at station 1124. Issued 1/22/80.	WE	United Airlines, Inc. San Francisco Int'l Arpt San Francisco, CA 94128

DC-8-61; *T.C. 4A25*	SA5510NM	Modification to permit an increased maximum zero fuel weight (MZFW), and maximum landing weight (MLW). Amended 11/15/96.	NM-L	Structural Integrity Engr 9560 Topanga Canyon Chatsworth CA 91311
DC-8-61; *T.C. 4A25*	ST00266AT	Installation of Pratt and Whitney JT3D-3B engines with long duct nacelles and cutback pylons. Reissued 8/8/94.	CE-A	Airborne Express Inc. 145 Hunter Drive Wilmington, OH 45177
DC-8-61, DC-8-62, -63, -71, -73; *T.C. 4A25*	SA1802SO	Installation of a cargo door, cargo restraint bulkhead, heavy duty flooring, etc., and provisions for 2 additional crew members. Amended 10/15/90.	CE-A	Rosenbalm Avn Inc. P.O. Box 10136 Macon, GA 31297
DC-8-61, -62, -62F, -63, -63F; *T.C. 4A25*	SA4892NM	Modification of the aircraft by installation of noise reduction nacelles. Amended 1/6/95.	NM-L	Burbank Aeronautical Corp. 3000 North Clybourn Ave Hangar 34 Burbank, CA 91505
DC-8-61F, -62F, -63F, -71F, -72F, -73F; *T.C. 4A25*	SA1606SO	Manufacture and installation of cabin/emergency exit window plugs. Issued 5/2/84.	CE-A	Delta Air Lines, Inc. Atlanta Hartsfield Int'l Arpt Atlanta, GA 30320
DC-8-62 (S/N 45925 only); *T.C. 4A25*	ST01363AT	Increase in aircraft operating weights (max landing weight - 250,000 lbs., max takeoff weight - 342,000 lbs.) Amended 11/28/97.	CE-A	Aircraft Modification Design Services, Inc. 8960 Ridgemont Drive Atlanta GA 30350
DC-8-62; *T.C. 4A25*	SA2819WE-D	Installation of Atlantic Aviation wide body kit. Issued 11/8/74.	WE	United Air Lines, Inc. San Francisco Int'l Arpt San Francisco, CA 94128
DC-8-62, -62F, -63, -63F; *T.C. 4A25*	SA1775GL	Incorporate maximum permissible quick turn-around landing weight (flaps 35...) Issued 7/20/92.	CE-C	ABX Air, Inc. 145 Hunter Drive Wilmington, OH 45177
DC-8-63; *T.C. 4A25*	SA1832SO	Installation of a cargo door and cargo interior. Reissued 5/8/95.	CE-A	ATAZ, Inc. P O Box 521477 Miami FL 33152
DC-8-63; *T.C. 4A25*	SA4844NM	Modification in accordance with FAA-approved data to permit an increase in maximum landing weight above 2,000 ft. Issued 3/1/90.	NM	Leth and Associates 85 222nd Place SE Redmond, WA 98052
DC-8-71 (S/N 46099 only); *T.C. 4A25*	ST00794AT	Increase in aircraft operating weights (max takeoff weight - 328,000 lbs., max landing weight - 258,000 lbs., max zero fuel weiht - 245,000 lbs.) Amended 4/24/97.	CE-A	Aircraft Modification Design Services, Inc. 8960 Ridgemont Drive Atlanta GA 30350
DC-8-73, 73F; *T.C. 4A25*	SA6058NM	Modification to permit increase in maximum allowable zero fuel weight .Amended 9/2/94.	NM-L	Altair Holdings Limited 111 N. First Street, Suite 301 Burbank, CA 91502

DC-9 Series; *T.C. A6WE*	SA4565SW	Installation of sunvisor assembly windshield and inner pane accoustic cabin window. Issued 12/14/81.	SW	Madeira Air Supply, Inc. 3330 Ribelin Way Garland, TX 75042
DC-9-11, -12, -13, -14, -15, -31, -32, -41; *T.C. A6WE*	SA1198SO	Conversion of aircraft from passenger to all cargo configuration. Amended 1/24/92.	CE-C	ABX Air, Inc. 145 Hunter Drive Wilmington, OH 45177
DC-9-11, -12, -13, -14, -15, -15F; *T.C. A6WE*	SA1563GL	Installation of a Stage 3 Hushkit on McDonnell Douglas DC-9-10 series when powered by Pratt & Whitney JT8D-7 series engines. Issued 2/19/91.	CE-C	ABS Partnership P.O. Box 532 Wilmington, OH 45177
DC-9-31, -32, -32F, -33F; *T.C. A6WE*	SA1613GL	Installation of Stage 3 hushkit when aircraft powered by (1) P&W JT8D7 series engines, (2) P&W JT8D-9 series engines. Amended 9/24/92.	CE-C	ABS Partnership 1111 Airport Road Wilmington, OH 45177
DC-9-31, -32, -32F, -33F; *T.C. A6WE*	SA1785GL	Installation of a Stage 3 hushkit on aircraft when powered by (1) P&W JT8D-9 Series engines, (2) P&W JT8D-7 Series engines. Issued 8/25/92.	CE-C	ABS Partnership 145 Hunter Drive Wilmington, OH 45177
DC-9-31, -32, -32F, -33F, -34, -34F, -41; *T.C. A6WE*	ST165CH	Installation of a Stage 3 hushkit when powered by Power & Whitney JT8D-7, -9, or -11 series engines. Issued 1/26/94.	CE-C	ABS Partnership 1111 Airport Rd Wilmington, OH 45177
DC-9-32; *T.C. A6WE*	SA2542SO	Installation of a cargo door. Reissued 9/22/94.	CE-A	Pemco Aeroplex, Inc. P.O. Box 2287 Birmingham, AL 35201
DC-10-10; *T.C. A22WE*	ST00312AT	Modification to allow passenger to freighter conversion. Issued 9/17/93.	CE-A	Federal Express Corp P.O. Box 727 Memphis, TN 38194
DC-10-40, -10-40F; *T.C. A22WE*	SA3139WE	Installation of wing and tail engine pods. Reissued 2/28/95.	NM-L	Rohr, Inc. 850 Lagoon Drive Chula Vista, CA 91910

Appendix F NDI DATABASE

On April 22nd, 1998, the Airworthiness Assurance Working Group (AAWG) generated an action item from the AAWG industry survey on technology readiness for detection of Widespread Fatigue Damage (WFD). Lockheed Martin, Airbus Industrie, Boeing, and the FAA tech Center had just given presentations on crack detectability, based on WFD occurring in four hypothetical structure configurations. The action item requested that the four industry participants coordinate their estimates into a single set of numbers for use by the committee.

The action item has been completed. Reducing NDT data into curves or numerical estimates is a risky activity. Over-simplifications of this sort can result in poor engineering decisions if used without cognizance of the many factors, which influence NDT inspections. However, the participants recognize the need for a basis on which to proceed with the committee's work.

Our response is contained in the data sheets that form a part of this Excel 4.0 file. It represents, in almost all cases, detectability under controlled (laboratory) conditions. Human factors, inspection surface conditions, operator experience level, and other variables have not been considered.
The data also represents use of the optimum NDT method. Many operators will not be using state-of-the-art equipment.

The "database" data sheet contains the individual responses from the participants. The shaded cells in the spreadsheet are those which were used to represent the industry. In most cases these are the largest of the crack sizes provided.

Where possible, 90/95 probability figures were used. However, these can also be subject to misinterpretation as described in the "FAA Tech Center Comment" worksheet of this file.

Assumptions and legends used in providing the estimates, other than those listed here, are shown on the data sheets themselves. The sheets should be printed out before review. Fax copies will be sent where necessary.

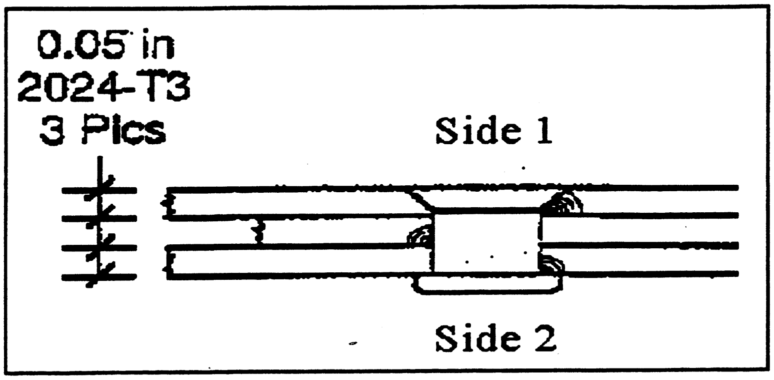
The estimates were provided by:

Daniel Bical (Airbus Industrie)
Don Hagemaier & Jeff Kollgaard (Boeing Commercial Airplane Group)
Don Pettit (Lockheed Martin Aerospace Systems)
Chris Smith & Floyd Spencer (FAA Technical Center)

Widespread Fatigue Damage Detectability – Database

(All cracks measured from shank of fastener, cracks numbered in ascending order from inspection side)

Case 1: Aluminum NAS1097-AD5 flush rivet



Side 1:

	Boeing		Airbus Industrie		Lockheed Martin		FAA Tech Center	
	Inches	mm	Inches	mm	Inches	mm	Inches	mm
CRACK 1:	[redacted]	[redacted]	0.08	2.0	0.05	1.3	[redacted]	[redacted]
	[redacted]	[redacted]			*0.035*	*0.9*	***0.032***	*0.8*
CRACK 2:	0.2	5.1	0.24	6.0	[redacted]	[redacted]		
	0.1	*2.5*			[redacted]	[redacted]		
CRACK 3:	0.3	7.6	[redacted]	[redacted]	0.3	7.6	0.24	6.1
	0.15	*3.8*			[redacted]	[redacted]	*0.12*	*3.0*

Side 2: Dimension shadowed by upset rivet assumed to be 0.020" (0.5 mm). Rivet upset assumed to be irregular.

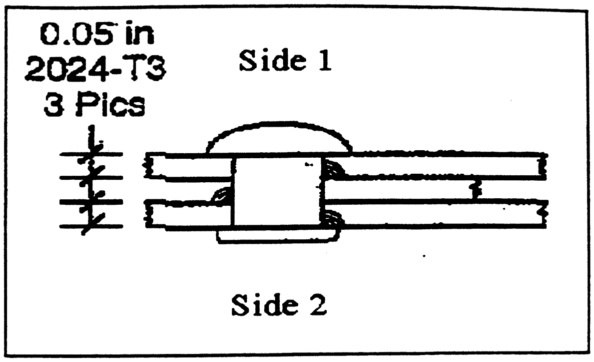
	Boeing		Airbus Industrie		Lockheed Martin		FAA Tech Center	
	Inches	mm	Inches	mm	Inches	mm	Inches	mm
CRACK 1:	0.083	2.1	[redacted]	[redacted]	[redacted]	[redacted]		
	0.08	*2.0*			[redacted]	[redacted]		
CRACK 2:	0.2	5.1	0.24	6.0	[redacted]	[redacted]		
	0.125	*3.2*			[redacted]	[redacted]		
CRACK 3:	0.3	7.6	[redacted]	[redacted]	0.3	7.6		
	[redacted]	[redacted]			[redacted]	[redacted]		

Key: current capabilities in plain text, *five year projections in italics,* **90/95 crack lengths in bold**

Widespread Fatigue Damage Detectability – Database

(All cracks measured from shank of fastener, cracks numbered in ascending order from inspection side)

Case 2: Aluminum MS20470 protruding head rivet



Side 1: 0.078" (2.0 mm) = dimension shadowed by MS20470 protruding head

	Boeing		Airbus Industrie		Lockheed Martin		FAA Tech Center	
	Inches	mm	Inches	mm	Inches	mm	Inches	mm
CRACK 1:	0.118	3.0	[redacted]	[redacted]	0.1	2.5	0.11	2.8
	0.088	*2.2*			[redacted]	[redacted]		
CRACK 2:	0.2	5.1	0.24	6.0	[redacted]	[redacted]		
	0.178	*4.5*			[redacted]	[redacted]		
CRACK 3:	0.3	7.6	0.31	8.0	[redacted]	[redacted]		
	0.228	*5.8*			[redacted]	[redacted]		

Side 2: Dimension shadowed by upset rivet assumed to be 0.078" (2.0 mm).
Rivet upset assumed to be irregular.

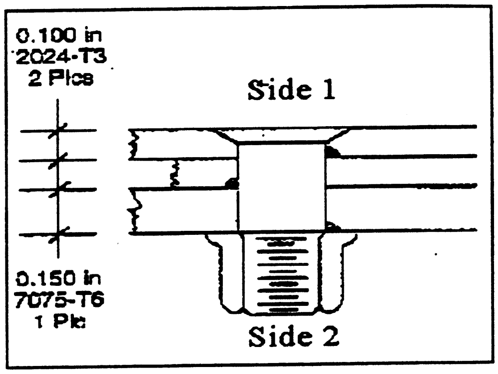
	Boeing		Airbus Industrie		Lockheed Martin		FAA Tech Center	
	Inches	mm	Inches	mm	Inches	mm	Inches	mm
CRACK 1:	[redacted]	[redacted]	0.1	2.5	0.1	2.5		
	[redacted]	[redacted]			*0.09*	*2.3*		
CRACK 2:	0.2	5.1	0.24	6.0	[redacted]	[redacted]		
	0.188	*4.8*			[redacted]	[redacted]		
CRACK 3:	0.3	7.6	[redacted]	[redacted]	0.3	7.6		
	0.238	*6.0*			[redacted]	[redacted]		

Key: current capabilities in plain text, *five year projections in italics*, **90/95 crack lengths in bold**

Widespread Fatigue Damage Detectability – Database

(All cracks measured from shank of fastener, cracks numbered in ascending order from inspection side)

Case 3: Titanium HLT-335 flush 0.250" (6.3 mm) diameter fastener



Side 1:

	Boeing		Airbus Industrie		Lockheed Martin		FAA Tech Center	
	Inches	mm	Inches	mm	Inches	mm	Inches	mm
CRACK 1:	0.1	2.5	0.1	2.5	[redacted]	[redacted]		
	0.1	*2.5*			[redacted]	[redacted]		
CRACK 2:	0.3	7.6	0.31	8.0	[redacted]	[redacted]		
	0.15	*3.8*			[redacted]	[redacted]		
CRACK 3:	0.55	14.0	[redacted]	[redacted]	0.6	15.2		
	0.25	*6.4*			[redacted]	[redacted]	***0.1***	***2.5***

Side 2: Dimension shadowed by fastener collar assumed to be 0.125" (3.2 mm).
No sealant cap present.

	Boeing		Airbus Industrie		Lockheed Martin		FAA Tech Center	
	Inches	mm	Inches	mm	Inches	mm	Inches	mm
CRACK 1:	0.125	3.2	0.12	3.0	[redacted]	[redacted]		
	0.1	*2.5*			[redacted]	[redacted]		
CRACK 2:	[redacted]	[redacted]	0.39	10.0	0.3	7.6		
	[redacted]	[redacted]			*0.25*	*6.4*		
CRACK 3:	[redacted]	[redacted]			0.6	15.2		
	[redacted]	[redacted]			*0.5*	*12.7*		

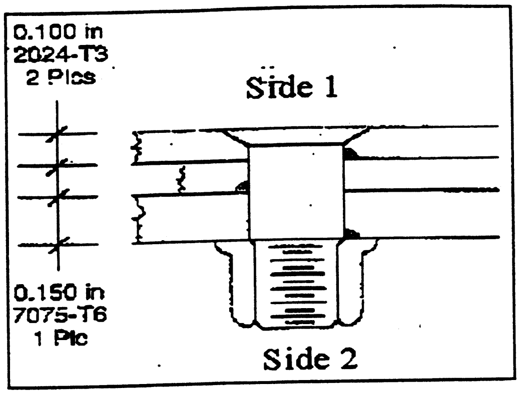
NOTE: Inspection for crack 3 from side 2 is a very unlikely inspection scenario.

Key: current capabilities in plain text, *five year projections in italics*, **90/95 crack lengths in bold**

Widespread Fatigue Damage Detectability – Database

(All cracks measured from shank of fastener, cracks numbered in ascending order from inspection side)

Case 4: Steel HLT-41 flush 0.250" (6.3 mm) diameter fastener



Side 1:

	Boeing		Airbus Industrie		Lockheed Martin		FAA Tech Center	
	Inches	mm	Inches	mm	Inches	mm	Inches	mm
CRACK 1:	[redacted]							
	[redacted]				*0.09*	*2.3*		
CRACK 2:	[redacted]		0.31	8.0	0.25	6.4		
	0.15	*3.8*			[redacted]			
CRACK 3:	[redacted]		0.79	20.0	0.4	10.2		
	0.25	*6.4*			[redacted]		***0.1***	***2.5***

Side 2: Dimension shadowed by fastener collar assumed to be 0.125" (3.2 mm). No sealant cap present.

	Boeing		Airbus Industrie		Lockheed Martin		FAA Tech Center	
	Inches	mm	Inches	mm	Inches	mm	Inches	mm
CRACK 1:	[redacted]		0.12	3.0	0.1	2.5		
					0.09	*2.3*		
CRACK 2:			0.39	10.0	0.25	6.4		
					0.2	*5.1*		
CRACK 3:					0.45	11.4		
					0.35	*8.9*		

NOTE: Inspection for crack 3 from side 2 is a very unlikely inspection scenario.
Key: current capabilities in plain text, *five year projections in italics*, **90/95 crack lengths in bold**

Appendix G PROPOSED ARAC TASKING STATEMENT FOR FOLLOW-ON TASKING

HARMONIZATION TERMS OF REFERENCE

TITLE OF INITIATIVE: FAR/JAR 25 AGING AIRCRAFT

AFFECTED FAR SECTION NUMBER (S): New FAR Sections(s) to be proposed.
AFFECTED JAR PARAGRAPH NUMBER (S): New JAR Sections(s) to be proposed.
NPA/NPRM NUMBER:
ADVISORY MATERIAL NUMBER:

BACKGROUND:

The FAA and JAA have been working together on the structural issues of aging aircraft to 1) assess the progress that has been made on the original eleven model aging aircraft, 2) identify any additional activities that are necessary to ensure the continued airworthiness of those aircraft and 3) apply the lessons learned on the original eleven model aging aircraft to other airplanes used in air transportation.

Under a previous ARAC tasking, the Airworthiness Assurance Working Group (AAWG) developed a new appendix to Advisory Circular 91-56. The appendix provides guidance on the development of a Widespread Fatigue Damage (WFD) prediction and verification technique to preclude operation of transport airplanes in the presence of WFD. Although the type certificate holders of the original eleven models agreed to develop a comprehensive evaluation program for potential WFD, commercial changes have affected some of the type certificate holders since that commitment was made and Advisory Circular 91-56 was revised. At this time the program is voluntary. The FAA was concerned that certain model specific programs may not be developed prior to the fleet leaders reaching their design service goal therefore the ARAC was tasked to provide guidance on how to proceed if the voluntary program does not protect the fleet.

ARAC was tasked to review the capability of analytical methods and their validation; related research work; relevant full-scale and component fatigue test data; and tear down inspection reports, including fractographic analysis, relative to the detection of widespread fatigue damage.

ARAC was also tasked to propose time standards for the initiation and completion of model specific programs (relative to the airplanes design service goal) to predict, verify and rectify widespread fatigue damage and to recommend action that the Authorities should take if a program, for certain model airplanes, is not initiated and completed prior to those time standards.

ARAC is in the final stages of completing this task and has issued an early recommendation that they be tasked to develop regulations to ensure that no large transport category airplane (>75,000 lbs. Gross Takeoff Weight) operates with widespread fatigue damage. This recommendation is based on evidence, gathered by ARAC from relevant tests and examples from service, that multiple site and multiple element damage exists in several different airplane types in the fleet. Such damage is a potential precursor to widespread fatigue damage.

Due to the extent of multiple site damage and multiple element damage that has been found in the fleet prompt action is necessary. This tasking warrants expeditious action to prevent a safety problem and to preclude unplanned grounding of a significant portion of the fleet of large transport airplanes due to a finding of widespread fatigue damage. ARAC has determined that there is a need to mandate that a widespread fatigue damage program is in place by Dec. 31, 2002.

SPECIFIC TASK:

ARAC is tasked to develop regulations (14 CFR part 25 and part 121 et. al) to ensure that one year after the effective date of the rule (e.g. Dec. 31, 2002), no large transport category airplane (> 75,000 lbs. Gross Take off Weight) may be operated beyond the flight cycle limits to be specified in the regulation unless an Aging Aircraft Program has been incorporated into the operators maintenance program.

The regulations and advisory material shall establish the content of the Aging Aircraft Program. This program shall cover the necessary special inspections and modification actions for the prevention of Widespread Fatigue Damage (WFD), Structural Modifications, Supplemental Structural Inspections Programs (SSIP)/Airworthiness Limitations Instructions (ALI), Corrosion Prevention and Control Programs (CPCP) and Structural Repairs. The regulations will also require the establishment of a limit of the validity of the Aging Aircraft Program where additional reviews are necessary for continued operation.

This Task shall be completed within 9 months of tasking.

Milestones:

A. Recommend a plan for completion of the task, including rationale, for FAA/JAA approval within three months of publication of this notice.
B. Give a status report on each task at each ARAC issues meeting.

CONTACTS:

REMARKS:

BENEFITS OF HARMONIZATION: Harmonization would improve safety by assuring a common approach to the aging aircraft program.

Pratt & Whitney
400 Main Street
East Hartford, CT 06108

Pratt & Whitney
A United Technologies Company

February 7, 2006

Federal Aviation Administration
800 Independence Avenue, SW
Washington, D.C. 20591

Attention: Mr. Nicholas Sabatini, Associate Administrator for Aviation Safety

Subject: ARAC Tasking, Airworthiness Assurance Working Group, Federal Register, May 13, 2004

Dear Nick,

The Transport Airplane and Engines Issues Group is pleased to forward the attached report from the Airworthiness Assurance Working Group as an ARAC recommendation. The Tasking requested the AAWG to consider how best to comply with the requirements set forth in 14 CFR 121.370a and 129.16, the Aging Airplane Safety Final Rule.

This final report is being submitted as a full consensus position of the AAWG.

The Task assigned from ARAC was split into two Phases and four subtasks. Subtasks 1, 2 and 3 are addressed in Phase 1 and Subtask 4 is addressed in Phase 2. The final report covers the activities specifically requested for Phase 1. Phase 2, Subtask 4 is also addressed but only as a proposed follow-on activity. In addition Subtasks 2 and 3 requested recommendations on how to best handle the specific issues of developing damage tolerance based inspections for alterations and a means to assess and provide maintenance actions for repairs alterations and modification that might be susceptible to the development of widespread fatigue damage. In concert with the ARAC request, recommendations on Subtask 2 and 3 are included in the report. These recommendations are included in Appendix E of the final report.

Phase 1, Subtask 1 requested that the AAWG develop an Advisory Circular for persons seeking compliance to 14 CFR 121.370a and 129.16 for repairs and repairs to alterations and modifications. This AC is included in the Final Report as Appendix B. Note that the report is intended to address part 121 aircraft with 30 or more passengers.

In the course of executing the task, Draft AC 91-56B was reviewed. The AAWG determined that this draft AC did not provide the necessary guidance to Certificate Holders seeking compliance to 14 CFR 121.370a and 129.16. The AAWG has proposed a new Draft AC 91-56x for FAA consideration. This Draft AC is included in the Final Report as Appendix C.

TAEIG would like to thank the AAWG for their effort on this difficult and complex task. There are many aspects to how repairs have been handled in the past and based on this review by the AAWG, there were several other conclusions and recommendations for further ARAC action. These are listed in the Executive Summary and Section 6 of the report.

Sincerely yours,

Craig R. Bolt

C. R. Bolt
Assistant Chair, TAEIG

Copy: Dionne Palermo – FAA-NWR
Mike Kaszycki – FAA-NWR
John Linsenmeyer – FAA- Washington DC, ARM-207
TAEIG Distribution List

U.S. Department
of Transportation
**Federal Aviation
Administration**

800 Independence Ave. S.W.
Washington, D.C. 2059·

MAR 13 2006

Mr. Craig R. Bolt
Assistant Chair, Aviation Rulemaking
Advisory Committee
Pratt & Whitney
400 Main Street, Mail Stop 162-14
East Hartford, CT 06108

Dear Mr. Bolt:

This is in reply to your letter to Mr. Nicholas Sabatini, dated February 7, 2006, transmitting a recommendation from the Airworthiness Assurance Working Group (AAWG). I understand members of the AAWG reached full consensus on the recommendation.

I wish to thank the Aviation Rulemaking Advisory Committee (ARAC), the members associated with Transport Airplane and Engine (TAE) Issues, and the TAE working groups that provided resources to develop the recommendation.

We consider your submittal of the recommendation as partial completion of Phase 1 of the ARAC tasking. We understand the AAWG will complete Phase 1 and Phase 2 of the tasking as a follow-on activity. We have forwarded the AAWG recommendation to the Transport Airplane Directorate for action. The recommendation will be placed on the ARAC website at: http://www.faa.gov/regulations_policies/rulemaking/committees/arac/.

We shall keep the committee apprised of the agency's efforts on this recommendation through the FAA report at future TAE meetings.

Sincerely,

Anthony F. Fazio
Director, Office of Rulemaking

A REPORT OF THE AIRWORTHINESS ASSURANCE WORKING GROUP

RECOMMENDATIONS CONCERNING ARAC TASKING FR Doc. 04-10816

RE: AGING AIRPLANE SAFETY FINAL RULE

14 CFR 121.370a AND 129.16

FINAL REPORT

October 28, 2005

SIGNED BY

Rao Varanasi

Co-Chairperson, AAWG

Boeing Commercial Airplanes

Mark Yerger

Co-Chairperson, AAWG

Federal Express

REVISION PAGE

LTR	DATE	CHANGE	PAGES ADDED	PAGES DELETED	PAGES CHANGED	APPROVED BY

Table of Contents

List of Figures

List of Tables

List of Abbreviations

The following abbreviations are used throughout this report

AASA	Aging Airplane Safety Act of 1991
AASFR	Aging Airplane Safety Final Rule
AASIFR	Aging Airplane Safety Interim Final Rule
AATF	Airworthiness Assurance Task Force
AAWG	Airworthiness Assurance Working Group
AC	Advisory Circular (FAR)
ACO	Aircraft Certification Office
AD	Airworthiness Directive
AIA	Aerospace Industries Association of America
ALS	Airworthiness Limitation Section
ARAC	Aviation Rulemaking Advisory Committee
ATA	Air Transport Association of America
ATC	Amended Type Certificate
CAA	Civil Aviation Authority
CAR	Civil Airworthiness Requirements
CFR	Code of Federal Regulations
DAH	Design Approval Holder
DSG	Design Service Goal
DT data	Damage Tolerance Data
DTE	Damage Tolerance Evaluation
DTIP	Damage Tolerance Inspection and Procedures
EASA	European Aviation Safety Agency
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
ISP	Inspection Start Point
LOV	Limit of Validity
MPD	Maintenance Planning Document
NDI	Non Destructive Inspection
NPRM	Notice of Proposed Rulemaking
OEM	Original Equipment Manufacturer
PMI	Principal Maintenance Inspector (FAA)
RAG	Repair Assessment Guidelines
RAM	Repairs, Alterations and Modifications
RAP	Repair Assessment Program
SB	Service Bulletin
SMP	Structural Modification Point
SRM	Structural Repair Manual
SSIP	Supplemental Structural Inspection Program
STC	Supplemental Type Certificate
STG	Structures Task Group
TAEIG	Transport Airplane and Engines Issues Group
TC	Type Certification
TCH	Type Certificate Holder
WFD	Widespread Fatigue Damage

List of References

The following is provided as a means to access current rules and regulations together with previous ARAC Recommendations from the AAWG. Documents noted by an (*) are available at the following web site.

http://www.faa.gov

1. Title 14 of the Code of Federal Regulations (14 CFR): The following Regulations are referenced in this report:

a. Part 21, §21.101*
b. Part 25, §§ 25.571*, 25.1529*
c. Part 43, §§ 43.13*, 43.16*
d. Part 91, § 91.403*
e. Part 121, §§ 121.368*, 121.370*, 121.370a*
f. Part 129, §§ 129.16*, 129.32*, 129.33*

2. Advisory Circulars (AC): The following Advisory Circulars are reference in this report:

a. AC 21.101-1, Change Product Rule*
b. AC 25.571-1, Damage Tolerance and Fatigue Evaluation of Structure*
c. AC 25.571-1A, Damage Tolerance and Fatigue Evaluation of Structure*
d. AC 25.571-1B, Damage Tolerance and Fatigue Evaluation of Structure*
e. AC 25.571-1C, Damage Tolerance and Fatigue Evaluation of Structure*
f. AC 25.1529-1, Instructions for Continued Airworthiness of Structural Repairs on Transport Airplanes*
g. AC 91-56A, The Continued Airworthiness of Older Airplanes*
h. AC 91-56B, The Continued Airworthiness of Older Airplanes*
i. AC 120-73, Damage Tolerance Assessment of Repairs to Pressurized Fuselages*

3. Other Documents referred to in this report:

a. A Final Report of the AAWG – Continued Airworthiness of Structural Repairs*
b. A Report of the AAWG – Recommendations for Regulatory Action to Prevent Widespread Fatigue Damage in the Commercial Airplane Fleet*
c. A Report of the AAWG - Recommendations For Regulatory Action To Enhance Continued Airworthiness Of Supplemental Type Certificates*
d. Repair Assessment Guidelines, FAA Approved Model Specific Guideline Documents**
e. FAA Approved Model Specific Supplemental Inspection Documents**
f. ATA Report 51-93-01 - Structural Maintenance Program Guidelines For Continuing Airworthiness***
g. ATA Response to FAA Docket 1999-5401 Dated May 5, 2003***
h. Federal Register/Vol. 69, No. 146/Friday, July 30, 2004/Rules and Regulations Fuel Tank Safety Compliance Extension (Final Rule) and Aging Airplane Program Update (Request for Comments). Page 45936*
i. A Report to the AAWG - Structures Task Group Guidelines Document, June 1996*
j. Federal Register/ Vol. 67, No. 235 / Friday, December 6, 2002 / Rules and Regulations Aging Airplane Safety

** Various manufacturers publish these documents. Please contact those manufacturers to determine the general availability of the documents.

*** Please contact the ATA.

Executive Summary

On May 13, 2004, the FAA published a new ARAC tasking and assigned it to the Transport Airplane and Engine Issue Group/Airworthiness Assurance Working Group. The Tasking requested Industry assistance in preparing guidance material for certificate holders wishing to show compliance to the Aging Airplane Safety Final Rule, 14 CFR 121.370a and 129.16. The Tasking consisted of four sub-tasks to be accomplished in two phases. In Phase 1, tasks 1, 2, and 3 are completed; in Phase 2, task 4 is completed.

In the process of completing the Task, several recommendations and conclusions were reached. In addition an Advisory Circular was developed in concert with the requirements of the Tasking. In the process of developing the tasking issues, the AAWG reached a total of 22 Conclusions and Recommendations.

Even though 14 CFR 121.370a and 129.16 could be construed to be applicable to repairs alterations and modifications to composite structure, the AAWG did not specifically develop guidelines for this particular type of structure. There were three principal reasons for this: (1) there is not a significant amount of composite primary structure on airplanes today; (2) most of that structure is on airplanes that were certified to Amendment 45 or later; and (3) the certification process in regards to damage tolerance for composite structure is significantly different than that of metallic structure and are adequately covered by AC 20-107A.

Compliance with the new Aging Airplane Safety Final Rule, 14 CFR 121.370a and 129.16 will require operators and DAHs to cooperatively develop data that, in some cases, does not currently exist. The AAWG recommends that this be accomplished through model specific STGs for both baseline structure as well as for repairs, alterations and modifications. Operators of applicable airplanes must have this data to show compliance by December 20, 2010. To this end, all updates to existing data should be published by December 18, 2009.

<u>Task 1 & 2 Conclusions and Recommendations (Repairs and Alterations/Modifications)</u>

The AAWG developed draft AC 120-AAWG to document the process for assessing repairs to fatigue critical structure. The proposed AC addresses repairs to both baseline structure as well as repairs to alteration and modifications. The AAWG believes that the proposed AC 120-AAWG contains sufficient guidance for DAHs to develop a Compliance Document which would support operator compliance with the AASFR for repairs.

Key to initiating this process is the identification of fatigue critical structure for each applicable airplane model. Repairs to the fatigue critical structure will need to be assessed for damage tolerance. Depending on the certification level of the aircraft

model and whether installed repairs are already covered by DT data, this may require a survey of the aircraft.
The conclusions and recommendations (***Bold Italicized***) from the AAWG tasking regarding repairs and repairs to alterations are documented in Sections 3 through 5 of this report. These are summarized below.

1. SSID programs and ALS were developed to address the un-repaired fatigue critical structure and do not consistently provide instructions for repairs to that structure.

2. The AAWG recommends that existing SBs, SRM, SSID programs and ALS programs for each applicable airplane be reviewed and updated to include DT data for all repairs to fatigue critical baseline structure as well as repairs to alterations and modifications by December 18, 2009.

3. The AAWG concluded that there are repairs and modifications to structural components susceptible to fatigue contained in the AMM and/or CMM and that these repairs and modifications are not under the same level of scrutiny that other repairs are subjected to.

4. The AAWG recommends that the FAA issue additional tasking to the ARAC to investigate the status of the AMM and CMM, and make appropriate recommendations.

5. The AAWG concluded that the development of RAG documents for the fuselage pressure boundary (fuselage skin, door skins, and bulkhead webs) provides vital information for operators to comply with 14 CFR 121.370 and 129.32 for the applicable airplanes.

6. The AAWG recommends that a generalized RAP program (includes greater coverage of fatigue critical structure than the pressurized boundaries) be considered and developed, if technically and economically feasible.

7. For those airplanes certified to Amendment 45 or later, where repairs to the fuselage pressure boundary were not provided with DT data, it is recommended that a Fuselage RAP program be developed in accordance with the guidance provided in AC 120-73, if economically feasible.

8. The AAWG recommends that the TAEIG task the AAWG to revise AC 120-AAWG to include a process for developing damage tolerance based maintenance inspections for alterations and modifications. A copy of the proposed tasking is included in Appendix E of this report.

9. The AAWG reviewed draft AC91-56B and made the determination that the guidance material does not provide adequate directions for an entity seeking compliance to AASFR.

10. The AAWG recommends that AC 91-56B be revised as delineated in Sections 2 and 3 of this report. A full draft of a proposed revision of AC 91-56B is included in Appendix C.

11. The AAWG reviewed AC 25.1529-1 and determined that the guidance material would not support compliance to the AASFR and further did not follow industry-accepted practice.

12. The AAWG recommends that AC 25.1529-1 be cancelled and incorporated in pertinent part into the proposed AC 120-AAWG.

13. The AAWG Recommends that AC 120-AAWG be promulgated as a means of compliance to 14 CFR 121.370a and 129.16 with respect to repairs. A copy of this AC is contained in Appendix B.

Task 3 Conclusions and Recommendations (WFD for RAMs)

14. For WFD evaluation, the AAWG concluded that the following two situations should be addressed:

a. The structural configuration of the RAM itself, if it is susceptible to WFD;

b. The effect of the RAM on baseline structure susceptible to WFD.

15. WFD actions for baseline structure should be defined prior to requiring an assessment of the effect of the RAM.

16. The determination of any maintenance actions required to preclude WFD should be done in context with the procedure defined in AC 120-AAWG for determination of the damage tolerance requirements for the RAM:

a. For those airplanes that need a survey to address DT for repairs, the WFD assessment should occur within the same timeframe (action and implementation plan;

b. For newer airplanes that will require WFD analysis for repairs and alterations, (e.g. 14 CFR Part 25 Amdt. 54 and beyond), the WFD action should occur when the airplane reaches DSG

c. For newer airplanes that only require WFD for alterations (e.g. 14 CFR Part 25 Amdt. 96 and beyond) the WFD action should occur at certification

17. Existing DAH documents, like the SRM and RAP, should be updated, in a timely fashion, to include consideration for WFD damage scenarios to support compliance to 121.WFD, where operation past DSG is defined.

18. To complete Task 3, the AAWG recommends that the TAEIG task the AAWG to assemble a group of technical experts for the development of the required technical basis on how to address WFD for RAMs. The work product of this activity would be material for inclusion in either FAA Advisory Circular 120-AAWG or yet another, to be determined, AC. A copy of the proposed Tasking is included in Appendix E of this report.

Task 4 Conclusions and Recommendations (Model Specific Programs)

19. The AAWG concurs with the ARAC Tasking in that it should oversee the timely development and implementation of model specific Compliance Documents and new and updated model specific data to support operator compliance.

20. The AAWG concurs that model specific STGs should be formed to identify the fatigue critical structure, and review existing data that could be used in support of compliance with the AASFR and that the AAWG oversee that activity.

21. The AAWG concluded that the cooperation of the Type Certificate Holders and the Design Approval Holders is necessary for operators to be able to comply with the AASFR.

22. The AAWG recommends that the DAH Model Specific Compliance Document, as delineated in AC 120-AAWG, be published by December 20, 2008, and the new and updated model specific data to support operator compliance be published by December 18, 2009. In addition, the AAWG recommends that the AAWG oversee the development of this data as delineated in Appendix E.

1. Introduction

A. New Tasking

On May 13, 2004, the FAA published a new ARAC tasking and assigned it to the Transport Airplane and Engine Issue Group/Airworthiness Assurance Working Group. The Tasking requested Industry assistance in preparing guidance material for certificate holders wishing to show compliance to the Aging Airplane Safety Final Rule, 14 CFR 121.370a and 129.16. The Tasking consisted of four sub-tasks to be accomplished in two phases. In Phase 1, Tasks 1, 2, and 3 are completed; in Phase 2, Task 4 is completed. The complete tasking statement is contained in Appendix A and summarized below.

1) Phase 1 – Preparation of Guidance Material

Phase 1 of the task requirements require the definition of guidance material and recommendations on the following subjects.

a) Task 1 – Repairs to Fatigue Critical Structure and Repairs to Alterations and Modifications

In Section 2 of this report, the AAWG has developed the rationale for the guidance material that will enable the operators to develop damage tolerance maintenance programs for repairs to fatigue critical structure and repairs to alterations and modifications. The actual proposed Advisory Circular is contained in Appendix B of this report. The FAA requested several subtask be evaluated in the development of the advisory material. These evaluations were conducted and the appropriate information included.

b) Task 2 – Alterations and Modifications

In Section 3 of this report the AAWG provides recommendations to the FAA on appropriate means to develop damage tolerance based maintenance programs for alterations and modifications. These recommendations are in the form of a request for an additional tasking to develop an amended Advisory Circular to include a process to develop the required programs

c) Task 3 – Consideration of Widespread Fatigue Damage for RAMs

In Section 4 of this report, the AAWG provides recommendations to the FAA on appropriate means to include the consideration of WFD prevention for installed repairs, alterations and modifications. These recommendations are in the form of a request for an additional tasking to develop an amended Advisory Circular to include a process to develop the required programs

2) Phase 2 – Task 4 Preparation of Compliance Data

Section 5 of this report briefly describes the expected process the industry will use to develop and implement the required programs.

B. Airworthiness Assurance Working Group

The AAWG is a duly constituted Federal Advisory Committee Act (FACA) entity. The AAWG reports to the Aviation Rulemaking Advisory Committee, Transport Airplane and Engine Issues Group (ARAC TAEIG). The AAWG was formed shortly after the 1988 Accident in Hawaii involving an older Boeing 737 in which a large section of fuselage departed the airplane. The AAWG has been active ever since examining the health of the fleet and proposing additional programs to maintain overall integrity of the commercial fleet. The membership of the AAWG consists of representation from:

ABx Air*
Airbus *
Airline Pilot's Association
American Airlines*
Air Transport Association
American West Airlines
Boeing Commercial Airplanes*
British Airways*
Continental Airlines*
Delta Air Lines Incorporated*
Evergreen International Airlines
Federal Aviation Administration*
Federal Express*
Fokker Service
International Air Transport
Japan Air Lines*
EASA*
Northwest Airlines*
Regional Airline Association
United Airlines*
United Parcel Service*
US Airways*

The AAWG established a task group to prepare and finalize the recommendations from this Tasking. The entities identified by an asterisk. A list of meeting venues and meeting attendance is documented in Appendix F respectively.

2. Task 1 - Development of Guidance Material for Repairs to Fatigue Critical Structure

A. Introduction

A significant change in the airworthiness standards for fatigue occurred in October 1978 with amendment 25-45 wherein §§ 25.571 and 25.573 of 14 CFR Part 25 were revised and deleted respectively. This change involved removing the fail-safe option in its entirety and establishing a new requirement to develop damage tolerance based inspections wherever practical. The fatigue strength approach was retained as a default option to be used only if the damage tolerance approach was shown to be impractical.

The same events and reasoning that drove the changes to airworthiness standards for new airplane also influenced the strategy adopted to ensure the continued airworthiness of the existing fleet. There was increasing concern with respect to existing older airplanes that had been certified in accordance with the fail-safe requirements of CAR 4b.270. Eleven large transport models were specifically identified as needing the most attention and it was decided that damage tolerance based inspection programs should be developed and implemented for these airplanes. These inspections were meant to supplement existing maintenance inspections and thus these programs were referred to as Supplemental Structural Inspection Programs (SSIPs) and the inspection requirements were documented in Supplemental Inspection Documents (SIDs). It was further agreed that the SIDs would be developed by the Original Equipment Manufacturers on a voluntary basis and then mandated by Airworthiness Directive (AD). Guidance for developing the SSIPs was published by the CAA in Airworthiness Notice No. 89, Continuing Structural Integrity of Transport Aeroplanes dated August 23, 1978 and by the FAA in Advisory Circular No. 91-56, Supplemental Structural Inspection Program for Large Transport Category Airplanes dated May 6, 1981. Subsequently SSIPs were developed and mandated by AD for the eleven aging models.

The damage tolerance concept has been adopted from the late 70s for the design, certification, and continued airworthiness of the new and existing aircraft models. However, these requirements have generally only been applied to the baseline structure. No system was in place requesting that repairs to Principal Structural Elements on these aircraft be evaluated to damage tolerance principles. The majority of these repairs were designed to an equal or better static strength requirement.

In response to accidents attributed in part to the aging of the airplane involved, the FAA sponsored in June 1988 a conference on aging airplane and as a result a task force was established representing the interests of the airplane operators, airplane manufacturers, regulatory authorities and other aviation representatives. In addition to other recommendations this task force specifically recommended that the damage tolerance of repairs should be considered. The following actions have been launched:

- The FAA published AC 25.1529-1 in 1991 to provide instructions to ensure continued airworthiness of structural repairs. This AC addresses the approval procedures to follow when making structural repairs to structure certificated under the damage tolerance requirements (including type designs with SIDs which were based on these criteria).

- In direct response to the task force recommendations changes were made to parts 91, 121, 125 and 129 of Title 14 of the CFR in April 2000 to require operators to incorporate damage tolerance based inspections for existing and future repairs to the fuselage pressure boundary for the eleven aging models previously identified. Other models and repairs to other structure were not addressed by the change.

- Model specific ADs have been issued on some of the eleven aging models that address repairs through the existing SSIDs.

Since the introduction of damage tolerance requirements in 1978, and its industry implementation over the years, the compliance status of structural repairs is rather complex to summarize:

- Damage tolerance based inspections have been incorporated for existing and future repairs to the fuselage pressure boundary of the eleven aging models. Existing and new repairs outside pressure boundary may not have been evaluated for damage tolerance.

- New repairs applied to structure certificated under the damage tolerance requirements should have been assessed for damage tolerance, and inspections incorporated as necessary to ensure their continued airworthiness.

1) Fatigue Critical Structure

14 CFR 121.370a/129.16 of the Aging Airplane Safety Final Rule (AASFR) requires operators to incorporate into their maintenance program damage tolerance based inspections and procedures for structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure. This category of structure is referred herein as "fatigue critical structure". The fatigue critical structure includes structure associated with alterations and modifications that are susceptible to fatigue cracking that could contribute to a catastrophic failure. It should be noted that in developing 14 CFR 121.370a/121.16 requirements, it was the intent of the FAA that the fatigue critical structure as defined in 14 CFR 25.571 must be assessed for damage tolerance.

2) Repairs to Fatigue Critical Structure

14 CFR 121.370a/121.16 also requires that repairs to the fatigue critical structure be assessed for damage tolerance. Repairs that are of interest for compliance to the AASFR are those repairs adversely affecting the fatigue life and inspection of the

fatigue critical structure. To preclude unnecessary DT assessments of repairs, the AAWG has identified certain types of repairs commonly made to the fatigue critical structure that have no adverse affect on the fatigue life and inspection of the structure. Task 1 of the FAA tasking requires an AC be written to provide guidance for developing DT data that operators can use for addressing repairs made to the fatigue critical structure. The AAWG has established AC 120-AAWG "Damage Tolerance Inspections for Repairs" to accomplish this task.

a) Repair Definition

For the purpose of this AC, a repair is defined as the restoration of an item to a serviceable condition in conformity with an approved standard.

The AC establishes provides guidance for determining when repairs need to be evaluated and which repairs will require evaluation. The AC will specify that the evaluation for these repairs be based on 14 CFR 25.571 and AC 25.571-1x (dependant on airplane certification level) and other guidance specific to repairs.

Even though 14 CFR 121.370a and 129.16 could be construed to be applicable to repairs alterations and modifications to composite structure, the AAWG did not specifically develop guidelines for this particular type of structure. There were three principal reasons for this: (1) there is not a significant amount of composite primary structure on airplanes today; (2) most of that structure is on airplanes that were certified to Amendment 45 or later; and (3) the certification process in regards to damage tolerance for composite structure is significantly different than that of metallic structure and are adequately covered by AC 20-107A.

b) Common repairs not affecting the fatigue life and or inspection of fatigue critical structure

For the purposes of the AC, existing repairs that need to be considered are those repairs that reinforce fatigue critical structure (e.g. restore strength); this typically excludes maintenance actions such as blend-outs, plug rivets, trim-outs, etc. The reason behind this limitation is that these maintenance actions are difficult to detect on the airplane and that records of such repairs are not normally kept past the next maintenance visit.

However, after December 20, 2010, blendouts, trim-outs, etc. that are beyond published DAH limits will require damage tolerance assessment as part of the compliance requirements to the AASFR.

c) Airplane Maintenance Manual/Component Maintenance Manual Restorations and Reworks

Manufacturers produce and distribute maintenance manuals for reworks, restorations and maintenance tasks for structural components conducted on and off airplane. The data and procedures contained in these manuals are FAA accepted procedures and have not necessarily been FAA approved.

The Airplane Maintenance Manual (AMM) directs maintenance tasks that can be accomplished on-airplane. This includes items such as lubrication system functional checks and servicing of the airplane. Structure repairs and modifications are not generally included in this manual except under special circumstances.

The Component Maintenance Manual (CMM) directs maintenance of components off-airplane. The maintenance tasks contained in this manual establishes accepted procedures for restoring a structural component to a serviceable state. As such, rework allowables along with refinishing procedures are often contained in this manual. Airlines can use this manual to restore components such as flap tracks, hydraulic actuators, and other components to a serviceable state without formal FAA approval.

The AAWG discussed whether or not reworks and restorations conducted under the provision of an AMM or CMM required consideration under the requirements of 14 CFR 121.370a/129.16 for the establishment of DT data. The AAWG concluded that it would be quite difficult to include these component reworks and restorations for the following reasons.

- The reworks and restorations within the limits contained in the DAH published AMM/CMM are reviewed by engineering and have not been known to adversely affect the life of the components.
- Certificate Holders are routinely allowed to modify the AMM/CMM based on service history with or without consulting the OEM. This has resulted in differing configurations for different certificate holders making the determination of a reworked baseline configuration difficult if not impossible to determine.
- A restored component, on airplane, would have no physical attributes to indicate that it had been reworked.
- Procedures for tracking the life or service history of a component, even if serialized, have not always been established or followed.
- In some cases a rework record of the component is not obtainable.
- Components from one airline could be interchanged with another airline.

After considering these points, the AAWG concluded that this issue should not be considered under the requirements of 14 CFR 121.370a/129.16 since inclusion of these reworks and restorations would be impossible to assess for compliance by December 20, 2010. The AAWG however believes that further review on this subject is advisable and recommends that the FAA issue a tasking to ARAC to investigate the status of the AMM and CMM and make appropriate recommendations.

d) Repairs to Removable Structural Components

Fatigue critical structure may include structure on removable structural parts or assemblies that can be exchanged from one aircraft to another (e.g. door assemblies, flight control surfaces, etc.). Therefore, repairs to such fatigue critical structure also require assessment for damage tolerance per 14 CFR 121.370a/121.16. While the general approach to assessment of these repairs is no different than for repairs to fixed structure, the AAWG found that removable structural parts present unique issues. These issues include:

- During their life history, these parts may not have had their flight times recorded on an individual component level. Additionally, they may have been removed and reinstalled on different airplanes multiple times. These actions may make it impossible to determine the actual age or total hours/cycles of a component or of a repair to a component. It also makes assigning a conservative age based on the component manufacturing date difficult (as is often done with fixed structure).

- Due to lack of clear guidance, there has been confusion in the industry regarding the need to track individual affected components under programs such as SSID or ALS. In many cases, the program rules could be interpreted to mean all requirements were tracked at the aircraft level even though some individual components were affected.

As a result of these findings, the AAWG concluded that additional guidance was necessary for repairs to removable structural components that were affected by the requirements of 14 CFR 121.370a/129.16. This guidance was included in AC 120-AAWG and addressed the issues listed above. In keeping with the theme of the tasking, a goal was to also provide guidance that gives flexibility and reduces operator burden when implementing DT data for repairs to structural components.

The guidance for removable structural components uses the same DT data development and implementation process applied to repairs on fixed structure; however, it gives tracking guidance and methods for conservatively assigning a component age. In developing this guidance, the AAWG considered existing industry approved recommendations for addressing removable structural components (Reference (3.f) – ATA Report 51-93-01, Section 4.6)

B. Task 1 Elements

Within Task 1, ARAC requested that the AAWG review and comment on several elements in preparation for the development of advisory material. The AAWG reviewed and commented on each of these elements below.

1) AC 91-56B Recommendations

The AAWG was requested to review the Draft AC 91-56B (Reference (2.h)) and assess its ability to provide the necessary guidance for an entity (more than just operator) that is seeking compliance to 14 CFR 121.370a/129.16. In Task 1, the Tasking requests ARAC to do the following for repairs:

In the process of drafting the AC, the ARAC should assess the effectiveness of AC 91-56B to provide guidance to TC and STC holders for developing damage-tolerance-based inspections and procedures for repairs made to aircraft structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure. The ARAC should do the following:

- ***Assess the effectiveness of AC 91-56B to support Industry compliance with the AASIFR with respect to repairs.***
- ***Document any improvements to the AC that would provide better direction with respect to the guidance for TC and STC holders in their development of damage-tolerance-based inspections and procedures for repairs.***

In Task 2, the ARAC was also requested to assess the effectiveness of Draft AC 91-56B to provide guidance for an STC holder in seeking compliance with 14 CFR 121.370a/129.16 for alterations and modifications, and provide recommended changes. While the specific discussion of the AAWG's findings are included in Section 3 of this report, the overall findings and recommendations were the same. Therefore, the recommended changes to Draft AC 91-56B associated with Task 2 were included in this section to avoid duplication or confusion.

a) Discussion of Proposed Changes

The AAWG reviewed Draft AC 91-56B and made a determination that the guidance provided did not provide adequate direction for an entity seeking compliance to 14 CFR 121.370a/129.16. The changes incorporated into Draft AC 91-56B did not address a variety of technical and programmatic issues that an entity would need to address for compliance to the rule. The results of trying to follow the Draft AC 91-56B would most likely result in a varying degree of compliance throughout the industry.

In making comments to the AC, the AAWG viewed Draft AC 91-56 as a top-level roadmap to the aging airplane programs that briefly describe the various programs and points to other ACs that provide specific guidance for each of the respective aging airplane programs. In support of this, the AAWG has developed a Draft AC 120-AAWG that provides guidance to the both the DAH and the operator on an acceptable means of compliance to 14 CFR 121.370a/129.16.

Further differences exist between the new FAA tasking contained in Federal Register Document 04-10816, dated 05-13-04, and the Draft AC 91-56B. The release of the new tasking reflects the FAA's current opinion of applicable structure that requires damage tolerance-based inspection program in accordance with the AASFR, 14 CFR 121.370a/129.16.

i. The Draft AC 91-56B reflects the wording of the Interim Final Rule Reference (3.j), that requires a damage tolerance-based inspection program for all major repairs, alterations and modifications.
ii. The FR 04-10816 requires a damage tolerance-based inspection program that addresses repairs made to aircraft structure and STCs that are susceptible to fatigue cracking that could contribute to catastrophic failure. The wording of FR 04-10816 and the AASFR published on February 2, 2005 are consistent.

b) Recommendations for Revisions to AC 91-56B:

The AAWG recommends that Draft AC 91-56B be revised as noted below. A copy of AC 91-56B with these changes annotated is contained in Appendix C.

i. Page 1, Paragraph 3. RELATED REGULATIONS AND DOCUMENTS.
   (1) Add subparagraph 3.a (4) add Parts 121.368, 121.370, and 121.370(a)
   (2) Add subparagraph 3.a (5) add Parts 121.16, 129.32, 129.33.
   (3) Add sub paragraph 3.b (4) add future AC 120-AAWG.

ii. Pages 4, 5. Paragraph 6.f. SUPPLEMENTAL STRUCTURAL INSPECTION PROGRAMS.
   (1) Page 4, Change first sentence to read, "The operators will be expected to accomplish a damage tolerance based inspection program of all alterations, modifications and repairs made to aircraft structure and STCs that is susceptible to fatigue cracking that could contribute to a catastrophic failure. This is to be done in accordance with the timelines established in the "Aging Airplane Safety" rule.
   (2) Page 5, Change the last sentence, last phrase to read, "... but the "Aging Airplane Safety" rule requires that all alterations, modifications and repairs made to aircraft structure and STCs that is susceptible to fatigue cracking that could contribute to catastrophic failure be considered."

iii. Page 5, Paragraph 7. MANDATORY MODIFICATION PROGRAM.
   (1) Add subparagraph 7.c. stating the "Aging Airplane Safety" rule requires that all modifications that are susceptible to fatigue cracking that could contribute to catastrophic failure be considered.

iv. Page 6, Paragraph 8 (c) CORROSION PREVENTION AND CONTROL PROGRAM (CPCP). Delete this subparagraph as the FAA has withdrawn rulemaking for the CPCP. Include a paragraph that stipulates industry standard practices.

v. APPENDIX 1, Page 1, Paragraph 1 (e).
   (1) Change the first two sentences to read, "The effect of repairs, alterations and modifications approved by the DAH and made to aircraft structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure, should be considered. In addition it will be necessary to consider the effect of all repairs and operator or STC-approved alterations and modifications on individual airplanes, which are made to aircraft structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure."

vi. APPENDIX 1, Page 5, Paragraph 6. STRUCTURAL REPAIRS, ALTERATIONS AND MODIFICATIONS.
   (1) Change the first sentence in subparagraph 6.a. to read, "Operators are responsible for ensuring that an assessment is made of all repairs, alterations and modifications (e.g., STCs) to aircraft structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure, to develop a damage tolerance based inspection program that ensures the same confidence as the baseline structure."
   (2) Change the second sentence in subparagraph 6.b. to read, "Repairs, alterations and modifications made to aircraft structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure, may invalidate these maintenance programs and would require additional analysis and/or testing."
   (3) Change subparagraph 6.c. to read, "Operators must accomplish a damage tolerance assessment for all new repairs, alterations and modifications to aircraft structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure."

2) Task 1, Element 1 - Airplane Certification Level

ARAC was requested to examine the following:

The significance of the airplane certification amendment level in providing direction for the development of damage tolerance inspections and methods for repairs.

Airplane certification amendment level provides a number of directions for the development of damage tolerance inspections and methods for repairs. For example, no direction exists for damage tolerance for airplanes certified prior to 14 CFR 25 Amendment 45; in the case of an airplane certified to 14 CFR 25 Amendment 54 and beyond, directions exist.

For the purposes of compliance to the AASFR, a more important question requires answering; that being "what amendment level should a respective airplane be required to show compliance?" The AAWG has considered this issue and provides the following response:

a) AASFR Rule Requirements

14 CFR Parts 121.370a and 129.16 require that *"maintenance programs include damage-tolerance based inspections and procedures for airplane structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure The inspections and procedures must take into account the adverse effects repairs, alterations and modifications may have on fatigue cracking and the inspection of this airplane structure."*

Alterations and modifications are discussed in Section 3 of this report. This section discusses repairs and repairs to alterations and modifications.

For new and existing repairs, Damage Tolerance Evaluations (DTE) must be accomplished for compliance to the AASFR. Basically, the amendment level of the 14 CFR 25.571 to be considered for this assessment may depend on the certification level of the airplane model, but also on the amendment level of the airworthiness requirements in force at the time of the assessment.

This section establishes the minimum amendment level to be considered for the Damage Tolerance (DT) justifications of repairs in the following categories:

- Existing repairs with an existing DT justification;
- Existing repairs without DT justification, that may require justification in the future;
- Future repairs that will require DT justification.

b) Chronology of 14 CFR 25.571

Table 2.1 summarizes the changes that have occurred to 14 CFR 25.571 and its predecessors since the introduction of commercial large transport category jet airplanes. Historically, the amendment level at time of certification determines the level of analysis required for the as delivered structure and any future repairs not considering the new requirements under 14 CFR 121.370a and 129.16.

TABLE 2.1 – CHRONOLOGY OF CHANGES TO 14 CFR 25.571

Date	Amendment Level	Change
Prior to 1965	CAR 4b – Fatigue Evaluation	Applicant had the option of certifying the structure either fail-safe or safe-life.
February 2, 1965	Conversion of CAR 4b to FAR25 - Fatigue Evaluation	Applicant had the option of certifying the structure either fail-safe or safe-life.
September 10, 1966	Amendment 25-10	Added requirement for sonic fatigue.
May 8, 1970	Amendment 25-23	Added dynamic effect factor of 1.15 on FS strength loads.
December 1, 1978	Amendment 25-45	Replaced the fail-safe requirement with a damage tolerance (fail-safe) requirement. Established inspections to be included in the maintenance manual required by 25.1529
October 14, 1980	Amendment 25-54	Established the Airworthiness Limitations Section of the Instructions for Continued Airworthiness
August 20, 1990	Amendment 25-72	Added PSD gust requirements, removed propellers from discrete source damage
March 11, 1996	Amendment 25-86	Revised gust loads
March 31, 1998	Amendment 25-96	Added requirement for 2-lifetime fatigue test for Widespread Fatigue Damage. Added requirement that inspection thresholds must be determined by crack growth for certain types of structure

The first obvious demarcation line as it relates to the AASFR is 14 CFR 25.571 Amendment 45. Aircraft certified after 14 CFR 25.571 Amendment 45 should theoretically have damage tolerance inspections in place for the type design. All repairs to these aircraft should have been evaluated from a damage tolerance viewpoint and any necessary inspections incorporated into the individual airplane maintenance program. However, industry accepted practices for airplanes certified to 14 CFR 25.571 Amendment 45 have not always provided damage tolerance data for repairs.

The damage tolerance standards established at Amendment 45 were not significantly revised until Amendment 96 which changed the way the inspection thresholds are to be determined:

> *"Inspection thresholds for [certain] types of structure must be established based on crack growth analyses and/or tests, assuming the structure contains an initial*

- ***Any significant issues in the implementation of the requirements of the damage-tolerance-based inspection programs/data***
- ***Data from the damage-tolerance based inspection programs that would be useful in supporting this new tasking***

The AAWG has examined these issues and responds with the following:

a) SSID/P and ALS Program Description

Supplemental Structural Inspection Documents/Programs (SSID/P) or equivalent documents/programs and the Airworthiness Limitations Section (ALS) of the Instructions for Continued Airworthiness provide inspections of Principal Structural Elements (PSEs) based on damage tolerance evaluations. Both the SSID/P and ALS were developed to support the continued airworthiness of airplanes. SSID/P programs are for airplanes certified prior to Amendment 45 of 14 CFR 25 and are based on the guidance given in AC 91-56A (Reference (2.g)). ALS programs have been developed for airplanes certified to Amendment 45 of 14 CFR 25 or later and are based on the guidance given in AC 25.571-1C and 14 CFR 25.1529.

The SSID/P and ALS were developed to define damage tolerance based inspections and are considered an acceptable means of compliance with the AASFR for the baseline structure. Further investigation must be done to determine fatigue critical structure so that that structure, when repaired, receives appropriate attention.

The SSID/P and ALS programs provide inspections on a limited number of structural areas of the airplane. The assumptions made in determining the areas to be inspected by OEMs contained in the SSID/P and ALS must be understood so that the determination of the fatigue critical structure required by §§ 121.370a and 129.16 is correct. It is likely that only the structure requiring supplemental inspection is included in the SSID/P and ALS documents. Structure that does not require supplemental inspection may also be classified as 'fatigue critical structure' since this structure's continued airworthiness is being controlled under a FAA approved normal maintenance program. Fatigue critical structure may require evaluation for supplemental inspections if repaired, altered or modified.

b) SSID/P or ALS Program Assumptions

In order for a SSID/P or ALS to be developed, a number of assumptions are required, including but not limited to:

i. Determination of PSEs,

ii. Stresses used for analysis,

iii. Airplane utilization,

iv. Size of initial flaws,

v. Probability of crack detection,

vi. Environment of the structure,

vii. Material properties and,

viii. Crack propagation methodology.

These assumptions are normally documented and approved by the FAA and provide a level of confidence in maintaining the continued airworthiness of the fleet. Any significant deviation from these assumptions can cause the effectiveness of the programs to change. Deviations include and are not limited to different airplane utilization, modifications and repairs.

Different airplane utilization may include length of flight, payload weight, cabin altitude, flight altitude, airplane retirement and predominant environment. Each of these could have a significant impact on the program. For example airplane retirements could impact the group of airplanes that are available for inspection in a program that samples the airplanes.

For those pre-amendment 45 airplanes, various manufacturers have produced and published SSID programs (See Reference (3.e)).

c) Normal Maintenance Issues

As previously discussed, normal maintenance is relied upon for a portion of the fatigue critical structure that does not require directed inspections. There were specific assumptions regarding normal maintenance contained in the SSID/P and ALS approvals. Those assumptions are relied upon to provide the necessary frequency and type of inspections to maintain continued airworthiness after the SSID/P or ALS threshold for a large portion of the fatigue critical structure. It is common practice within the industry to escalate maintenance intervals as experience with the airplane and its operational environment become better known. It is important for those entities seeking compliance to 14 CFR 121.370a/129.16 to understand those assumptions and make the appropriate adjustments to the normal maintenance program at the SSID/P or ALS threshold. Some ALS programs already require this adjustment.

d) Status of SSID/P and ALS Programs by Airplane Model

Table 2.3 summarizes the current status of all Airbus and Boeing SSID/P and ALS programs.

TABLE 2.3A – AIRPLANES WITH SSID AD DTA REQUIREMENTS FOR REPAIRS ALTERATIONS AND MODIFICATIONS

Airplane / AD Number	FAR 25/25.571 Amdt	DTA of New Repairs		DTA of Old Repairs	AC 25.1529-1 applies	AD addresses Alterations or Modifications
		Before SSID Program Threshold	After SSID Program Threshold			
727 (All) / 98-11-03 R1	CAR 4b/Pre FAR	Yes	Yes	At Threshold	Yes – except for AD	Yes
737 (100 & 200) / 98-11-04 R1	15/0	Yes	Yes	At Threshold	Yes – except for AD	Yes
737 – 300, 400, and 500 AD Pending	51/0	No at this time	Yes Fuselage / RAP	Yes Fuselage / RAP	AD will specify Compliance Requirements	N/A
747 (All) / 2004-07-22	39/0	No	Yes	At Threshold.	Yes – Initial approval "FAA" then final approval needs AMOC.	Yes – needs AMOC.
A300 (B2-1A, B2-1C, B2K-3C, B2-203 B4-2C, B4-103, & B4-203) / 96-13-11	20	Yes*	Yes*	N/A	Yes	N/A
DC-8 (All) 93-01-15	0/0	No	Yes only if per AD	Implied	No – needs AMOC or ACO approval	No
DC-9 (10 – 50) / 96-13-03	0/0	No	Yes only if per AD	At Nth	No – needs AMOC or ACO approval	No
DC-10 (All) / 95-23-09	22/10	No	Yes only if per AD paragraph	At Nth AD paragraph	No – needs AMOC or ACO approval AD paragraphs	No

Airplane / AD Number	FAR 25/25.571 Amdt	DTA of New Repairs		DTA of Old Repairs	AC 25.1529-1 applies	AD addresses Alterations or Modifications
		Before SSID Program Threshold	After SSID Program Threshold			
DC-9 (81, 82, 83, 87) & MD-88 / AD 2004-11-07	40/10	No	Yes AD paragraph	Yes AD paragraph	Yes AD paragraph (e) & Note 2. No AD paragraph	Yes AD paragraph

* RAS embodied after 1992

TABLE 2.3B – AIRPLANES WITH ALS DTA REQUIREMENTS FOR REPAIRS ALTERATIONS AND MODIFICATIONS

Airplane / AD Number	FAR 25/25.571 Amdt	DTA of Repairs	AC 25.1529-1 applies	AD addresses Alterations or Modifications
717 (200)	82/72	Yes	Yes	N/A
737- 600, 700, 800	Fuselage and empennage 77/0 Wing 77/72	Yes	AD will specify Compliance Requirements	N/A
737-700C, 900	91/86	Yes	Yes	N/A
757 L/N 1-764 / 2001-20-12	85/45	Yes	Yes	No
757 L/N 765 and beyond	85/45	Yes	Yes	N/A
767 L/N 1-668 / 2001-08-28	89/45	Yes	Yes	No
767 L/N 669 and beyond	89/45	Yes	Yes	N/A
777	(Series 200/300) 86/72 (Series 300ER) 98/96	Yes	Yes	N/A
A300 (600)	45/45	Yes*	Yes	N/A
A310	45/45	Yes*	Yes	N/A
A318	86/86	Yes	Yes	N/A
A319	86/86	Yes	Yes	N/A
A320	54/54	Yes*	Yes	N/A
A321	54/54	Yes	Yes	N/A

Airplane / AD Number	FAR 25/25.571 Amdt	DTA of Repairs	AC 25.1529-1 applies	AD addresses Alterations or Modifications
A330	72/72	Yes	Yes	N/A
A340	72/72	Yes	Yes	N/A
MD-10 (10F & 30F)	Structure not affected by change - Same as DC-10 Structure affected by change 89/86	No** AD Pending	Yes	N/A
MD-11 (All)	61/54	Yes	Yes	N/A
MD-90 (30) / 97-11-07	70/54	Yes	Yes	N/A

* RAS embodied after 1992

** AD will specify Compliance Requirements

e) Summary and AAWG Recommendations

i. Those areas of the fatigue critical structure that require supplemental inspections are listed in the SSID/ALS. Areas of the fatigue critical structure not listed in the SSID/ALS will require evaluation for supplemental inspections if repaired, altered or modified.

ii. If an operator has escalated his baseline maintenance structural task intervals, an adjustment to operator's baseline maintenance program may be necessary at SSID/P or ALS thresholds, depending on the assumptions used to establish the SSID/P and ALS.

iii. There is little consistency between the various SSID/P and ALS programs relative to how those programs provide direction to repair the structure using damage-tolerance-rated repairs. Further review has established that the AASFR will provide the means to provide consistency in the handling of repairs to SSID/P and ALS structure.

iv. The SSID/P and ALS programs were developed to address the un-repaired fatigue critical structure and do not consistently provide instructions for repairs to that structure. Therefore, the AAWG has concluded that there is no data from the SSID/P and ALS programs which are specifically useful in supporting the new tasking.

v. The AAWG recommends that the model-specific Compliance Documents described in proposed AC 120-AAWG contain a statement which confirms that the FAA-approved SSID/P or ALS for that airplane model is an acceptable means of compliance for the AASFR, for the baseline structure of that airplane model.

4) Task 1, Element 4 - Effectiveness of RAP Documents in providing DT data

ARAC was asked to consider the following concerning Repair Assessment Programs:

The degree to which existing Repair Assessment Guideline documents developed for §§ 121.370 and 129.32 provide damage-tolerance-based inspections for repairs made to aircraft structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure. The assessment should identify the following:

- ***Areas of the aircraft structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure, which are not covered by these documents***
- ***Data from these documents that would be useful in supporting this new tasking***

The AAWG has considered this issue and provides the following response:

a) RAP Program Description

On December 9, 2002, a requirement for a Repair Assessment Program (RAP) (14 CFR 121.370 - Amdt. 121–295, 67 FR 72834) requiring DT data for repairs to the fuselage pressure boundary was introduced for 11 airplane types. These 11 types were all certified to pre-Amendment 45 to 14 CFR 25, including:

- Airbus A300
- BAC 1-11
- B707/720
- B727
- B737
- B747
- F-28
- L1011
- DC-8
- DC-9/MD-80
- DC-10

The RAP is a program that is limited to repairs of the fuselage-pressurized boundaries (fuselage skin, door skin and bulkhead webs). The programs were developed based on a series of studies conducted for the FAA by the Airworthiness Assurance Working Group (See Reference (3.a)). The study conducted two surveys of airplanes in 1992 and 1994 in which 1051 repairs installed on 65 airplanes of 9 different models were assessed. The major conclusions of the assessment were that

- 60% of the repairs would need damage tolerance evaluation,
- Majority of the repairs were on the fuselage (less than 10% on other structure),
- There were no immediate safety concerns, and
- Old aircraft had more repairs.

Based on these studies the AAWG concluded that repairs to the fuselage pressure boundary were of the highest priority for potential problems that could affect continued airworthiness.

Operators who have adopted an FAA approved assessment procedure in their maintenance programs are fully compliant with the requirements of the AASFR for the structure identified in the assessment programs. To be in compliance to AASFR, other components of the fuselage not covered would require FAA approved programs.

A model specific RAP document (Reference (3.d)) developed in accordance AC120-73 (Reference (2.i)) provides guidance to determine the inspection threshold, interval and method for each repair as required. Repairs that have been assessed according to these guidelines are in compliance with the requirements of the AASFR. Repairs that go beyond the scope of the RAP document or other approved data (such as SRM) may require additional regulatory approvals in defining the maintenance requirements for compliance to the AASFR.

b) ATA Assessment of AASIFR Impact to Industry

The ATA, in responding to the December 2002 publication that promulgated the Aging Airplane Safety Interim Final Rule (AASIFR), indicated that approximately 142,600 repairs (on Boeing Airplanes alone) and 3300 STCs would need to be assessed for damage tolerance under the requirements of the AASIFR (Reference (3.g)). There is a need to determine whether a RAP program generalized to all fatigue critical structure would be an effective means to support operator compliance as opposed to reviewing and providing DT data on an individual repair-by-repair basis.

The AAWG recommends that the technical and economic merits of a generalized RAP program for all fatigue critical structure be considered and developed if feasible. In all cases, the operator must have the necessary data to show compliance by December 18, 2009.

c) Requirements on Other Airplanes Not Affected By RAP

In regard to the fuselage pressure boundary, all other aircraft types / models are still required to comply with AASFR. Damage tolerance assessment methods and inspection procedures will need to be introduced for repairs accomplished on these aircraft.

d) AAWG Critique of the RAP Program

The consensus of the AAWG is that the development of the RAG documents for the Fuselage Pressure Boundary Repairs was vital for the implementation of this program. The success of the 14 CFR 121.370 program can be attributed to the cooperation of all segments of the industry including the FAA, operators and manufacturers.

Considering the newness of the program only very limited data is available that provides some insight as to the effectiveness of the RAG documents. Three operators were surveyed concerning how successful the RAG documents had been in assessing repairs to the fuselage pressure boundary. The application of these programs is limited to the older airplanes and there is only limited experience available. The results of this survey are encouraging in that the process assessed and provided DT data for a large percentage of the repairs. The Table 2.4 documents the results of the survey

TABLE 2.4 – SUMMARY OF RAG DOCUMENTS REPAIR CATEGORIZATIONS

Airline	Number of A/P	Average No of Repairs per A/P on the Fuselage Pressure Boundary	Percentage Successfully Assessed per A/P using RAG Documents
A	60	37	70%
B	48	71	91%
C	N/A	N/A	50%

The operators provided the OEMs with a critical review of the existing RAP documents developed for operator compliance to 14 CFR 121.370. It was pointed out that the operators were still relatively new to the document and that not many airplanes currently required assessment. The operators defined four main issues that they would like to be resolved for each of the two OEMs. The following summarizes their positions:

TABLE 2.5 – RAP PROGRAM IMPROVEMENTS

AIRBUS	BOEING
Provide Flexible Inspection Options	Automate the Process
Automated/Simplified Process	Provide Flexible Inspection Options
Improved navigation/document layout	Include Removed/Superceded SRM Repairs with DTA Information
Provide BZI/MPD Correlation	Provide BZI/MPD Correlation

The operators pointed out that by making these adjustments to the existing RAP, the OEM would effectively reduce the number of repairs that would require evaluation by the OEM or third party.

e) AAWG Conclusions and Recommendations

i. Fuselage RAP programs are successful

ii. The AAWG recommends that the technical and economic merits of a generalized RAP program for all fatigue critical structure should be considered and developed if feasible. In all cases, the operator must have the necessary data to show compliance by December 18, 2009.

iii. For those airplanes certified to Amendment 45 or later where repairs to the fuselage pressure boundary were not provided with DT data, it is recommended that a Fuselage RAP program be developed in accordance with the guidance provided in AC 120-73.

5) Task 1, Element 5 - Comparison of Approaches used to require DT data for repairs in SSID/P areas.

ARAC was asked to consider the following:

Identify the issues/difficulties industry has encountered with establishing damage-tolerance-based inspections and procedures for repairs as required by various FAA approaches in issuing SSIP airworthiness directives (e.g., 727/737 AD 98–11–03 R1, AD 98– 11–04 R1 verses other SSIP AD approaches like the 747). The assessment should identify the following:

- ***Comparison of approaches with pros and cons for each approach***
- ***Data from these documents that would be useful in supporting this new tasking***

The AAWG has considered this issue and provides the following response:

The various approaches adopted in the promulgation of the SSID ADs will have no effect on compliance requirements of the AASFR. The approach of the 727 and 737 SSID ADs relative to existing repairs are, in practice, very similar to the approach outlined in proposed AC 120-AAWG. With regard to the approach the FAA chose to take on the 747 SSID, the AAWG determined that no useful guidance was given with respect to the requirements for DTA on repairs. In effect the AD only addresses inspectability issues with repairs that would hinder SSID inspections.

6) Task 1, Element 6 - Effectiveness of SRMs in providing DT data

ARAC was asked to consider the following:

The extent to which Structural Repair Manuals (SRM) provide damage-tolerance-based inspections for repairs made to aircraft structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure.

The AAWG has considered this issue and provides the following response:

The inclusion of DT based inspections in Structural Repair Manuals (SRMs) is based on the certification amendment level of the airplane or otherwise required by rules such as 14 CFR 121.370 or ADs that mandate programs like the SSID. Repairs to airplanes certified prior to 14 CFR 25 Amendment 45 have not been assessed for damage tolerance. However, all repairs contained in the SRMs for airplanes certified to 14 CFR 25 Amendment 45 or later are generally designed to be damage tolerant. SRMs for these airplanes, may or may not document DT based inspections. For repairs that are in the SRM and do not have DT based inspections documented, safety is ensured, in part, by the normal maintenance programs supplemented by inspections required by either the SSID or ALS. With the requirements of 14 CFR 121.370a and 129.16, each of the Model Specific SRMs will need to be reviewed and updated to include DT inspections, if needed, for all repairs to fatigue critical structure. Tables 2.6 through 2.8 document the current status of SRMs for certain large category airplanes subject to the AASFR.

TABLE 2.6 - AIRBUS SRM AND INDIVIDUAL REPAIR DT STATUS

Airplane Model	***FAR 25.571 Cert. Level***	***Current SRM Repairs***	***New Incorporated SRM Repairs***	***SRM DT Fully Compliant[3]***	***Individual Repairs DT Status***		
					OLD	CURRENT	FUTURE
A300	25-10	DT[1]	DT	2008	Since 92[2]	DT	DT
A300-600	25-45	DT[1]	DT	2008	Since 92[2]	DT	DT
A310	25-45	DT[1]	DT	2008	Since 92[2]	DT	DT
A 318	25-86	DT[1]	DT	2008	DT	DT	DT
A 319	25-86	DT[1]	DT	2008	DT	DT	DT
A 320	25-54	DT[1]	DT	2008	Since 92[2]	DT	DT
A 321	25-54	DT[1]	DT	2008	DT	DT	DT
A330	25-72	DT	DT	Today	DT	DT	DT
A340	25-72	DT	DT	Today	DT	DT	DT

1. All repairs Damage Tolerant, Some repairs may lack specific DT based maintenance inspection requirements
2. Covered by AIRBUS Repair Design Approval Sheet
3. SRM contains DT based maintenance inspection requirements for all repairs

TABLE 2.7 - BOEING SRM AND INDIVIDUAL REPAIR DT STATUS

Airplane Model	FAR 25.571 Cert. Level	Current SRM Repairs	New Incorporated SRM Repairs	SRM DT Fully Compliant[6]	Individual Repairs DT Status		
					OLD	CURRENT	FUTURE
B 707	CAR 4b	No	No	?	DT[5]	DT[5]	2010
B 727	CAR 4b	DT[5]	DT[5]	2009	DT[5]	DT[5]	2010
B 737 CL	Amdt 0[1]	DT[5]	DT[5]	2009	DT[5]	DT[5]	2010
B 737-600/-700/-800 Fuselage and Empennage	Amdt 0	DT[5]	DT[5]	2009	DT[5]	DT[5]	2010
B 737-600/-700/-800 Wing	Amdt 72	DT	DT	2009	DT[4]	DT[4]	DT[4]
B 737-700C/-900	Amdt 86	DT[5]	DT	2009	DT[4]	DT[4]	DT[4]
B 747	Amdt 0[2]	DT[5]	DT[5]	2009	DT[5]	DT[5]	2010
B 757	Amdt 45	DT[5]	DT	2009	DT[4]	DT[4]	DT[4]
B 767	Amdt 45	DT[5]	DT	2009	DT[4]	DT[4]	DT[4]
B 777	Amdt 72[3]	DT	DT	At TC	DT[4]	DT[4]	DT[4]
DC-8	CAR 4b	DT[5]	DT[5]	2009	DT[5]	DT[5]	2010
DC-9	CAR 4b	DT[5]	DT[5]	2009	DT[5]	DT[5]	2010
DC-10	Amdt 10	DT[5]	DT[5]	2009	DT[5]	DT[5]	2010
MD-80	Amdt 10	DT[5]	DT[5]	2009	DT[5]	DT[5]	2010
MD 11	Amdt 54	DT	DT	At TC	DT[4]	DT[4]	DT[4]
MD-90	Amdt 54	DT	DT	At TC	DT[4]	DT[4]	DT[4]
B 717	Amdt 72	DT	DT	At TC	DT[4]	DT[4]	DT[4]

1. Strut on 737-300/-400/-500 DT Cert level is Amdt 45
2. Strut on L/N 1047 and on DT Cert level is Amdt 45
3. 300ER DT Cert level is Amdt 96 (has equivalent safety finding for WFD
4. May be limited to assessment of a threshold where supplemental inspections are required.
5. All repairs Damage Tolerant, Some repairs may lack specific DT based maintenance inspection requirements
6. SRM contains DT based maintenance inspection requirements for all repairs

TABLE 2.8 - OTHER MANUFACTURERS SRM AND SB DT STATUS

Airplane Model	25.571 Cert. Level	Baseline Structure	SRM Status	SBs DT Fully Compliant
SAAB 340/2000	Post 54	Cert Level- ALS	DT rated	DT rated
CL-600	Post 45	Cert Level - ALS	DT rated	DT rated
CASA CN-235	*	*	*	*
DHC-8	Post 54	Cert Level	DT rated	DT rated
DHC-7	Pre-45	Mini SSIP- AD Issued	Not DT rated	Not DT rated
DO 328-100/300	Post 54	Cert Level	DT rated	DT rated
ATR 42/72	54	Cert Level - ALS	DT rated	DT rated
EMB 135/145	Post 54	Cert Level - ALS	DT rated	DT rated
BAE146-100/200	45	Cert Level	Not DT rated	Not DT rated
BAE146 AVRO & -300	54	Cert Level	Not DT rated	Not DT rated
F-27 Basic	Pre 45	SSID	Not DT Rated	Not DT Rated
F-28 Basic	Pre 45	SSID	DT Pressure Boundary	DT Pressure Boundary
Fokker 50/70/100	Post 54	Cert Level -ALS	DT Rated	DT Rated
CV [3]580STC/[3]640STC	Pre 45	No SSID	Not DT rated	Not DT rated
BAE Jetstream-4100	Post 54	Status is pending	Status is pending	Status is pending
Lockheed L-1011	25-10	*	*	*
Lockheed L-188	*	*	*	*
Lockheed L-382	*	*	*	*
EMB 120	Pre 54	Cert Level-ALS	DT Rated	DT Rated

* Information was requested but not received from the DAH

7) Task 1, Element 7 - The need to require DT data in TC and STC Holder Issued Service Bulletins

ARAC was asked to consider the following:

Assess the need to include damage-tolerance-based inspections and procedures in TC and STC Holder issued Service Bulletins (SB) that provide repair instructions for aircraft structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure.

The AAWG has considered this issue and provides the following response:

The requirement for inclusion of DT data in service bulletins is driven by the certification level of the airplane and in some cases, the amended certification level as established by an Airworthiness Directive. With some exceptions, airplanes certified to Amendment 45 of 14 CFR Part 25 (or higher) require Service Bulletin modifications to primary structure to have DT data included within the SB instructions. The AASFR will place further requirements to have SBs that are damage tolerant for all areas of fatigue critical structure. With the requirements of 14 CFR 121.370a and 129.16, each of the Model Specific SBs will need to be reviewed and DT data provided for repairs to fatigue critical structure. Table 2.9 and 2.10 documents industry status on Service Bulletin information. Note: Some manufacturers information is contained in Table 2.8.

TABLE 2.9 - SB DT STATUS AIRBUS

Airplane Model	*25.571 Cert. Level*	*Current SBs* [3]	*New SBs* [3]	*SBs DT Fully Compliant*
A300	25-20	DT	DT	As part of life extension[1]
A300-600	25-45	DT	DT	From TC[2]
A310	25-45	DT	DT	From TC[2]
A 318	25-86	DT	DT	From TC
A 319	25-86	DT	DT	From TC
A 320	25-54	DT	DT	From TC[2]
A 321	25-54	DT	DT	From TC
A330	25-72	DT	DT	From TC
A340	25-72	DT	DT	From TC

NOTES:
1. Mod. Since SSID, repairs after life extension
2. Mod. Since TC, repairs after life extension
3. SB review necessary during life extension exercise

TABLE 2.10 - SB DT STATUS BOEING

Airplane Model	*25.571 Cert Level*	*Current SB*[5]	*New SB*[5]	*SB DT Fully Compliant*
B 707	CAR 4b	No	Partially DT	?
B 727	CAR 4b	Partially DT	Partially DT	2009[4]
B 737 CL	Amdt 0[1]	Partially DT	Partially DT	2009[4]
B 737-600/-700/-800 Fuselage and Empennage	Amdt 0	Partially DT	Partially DT	2009[4]
B 737-600/-700/-800 Wing	Amdt 72	DT	DT	2009[4]
B 737-700C/-900	Amdt 86	DT	DT	2009[4]
B 747	Amdt 0[2]	Partially DT	Partially DT	2009[4]
B 757	Amdt 45	Partially DT	DT	2009[4]
B 767	Amdt 45	Partially DT	DT	2009[4]
B 777	Amdt 72[3]	DT	DT	At Cert
DC-8	CAR 4b	Partially DT	Partially DT	2009
DC-9	CAR 4b	Partially DT	Partially DT	2009
DC-10	Amdt 10	Partially DT	Partially DT	2009
MD-80	Amdt 10	Partially DT	Partially DT	2009
MD 11	Amdt 54	DT	DT	At TC
MD-90	Amdt 54	DT	DT	At TC
B 717	Amdt 72	DT	DT	At TC

NOTES:
1. Strut on 737-300/-400/-500 DT Cert level is Amdt 45
2. Strut on L/N 1047 and on DT Cert level is Amdt 45
3. 300ER DT Cert level is Amdt 96 (has equivalent safety finding for WFD)
4. SBs or document containing DT data for each SB
5. All Service Bulletins will need a review no matter what the certification level is.

C. Discussion of AC

1) Method of Approach – DAH Compliance Document and Operator Implementation Plan

a) Why the AAWG chose to utilize an ACO approved data package (DAH Compliance Document)

In developing an approach that would facilitate the operators' timely compliance with the AASFR with respect to repairs, the AAWG determined that it would be necessary for operators to have access to an ACO approved data package containing the DT data required for compliance. This data package, termed "Compliance Document", would contain a listing of available DT data, developed by a DAH, and a means to obtain FAA Approved DT data, for unique repairs. The compliance document would be submitted to the FAA ACO for approval. This process is similar in principle to that conducted by Type Certificate Holders in support of operator compliance with the § 121.370 Repair Assessment Rule.

The compliance documentation developed by the DAH and approved by the ACO would encompass all fatigue critical structure, including repairs and repairs to Repairs, Alterations, and Modifications (RAM) as necessary, and should include implementation schedule information. The listing of available DT data and the means to obtain data for unique repairs should provide the data necessary to support an operator's development of an Implementation Plan. An ACO approved Compliance Document will facilitate the operators' ability to identify and incorporate into their maintenance program the DT data necessary to support compliance with §§ 121.370a and 129.16.

b) Why the AAWG Chose to Utilize a PMI Approved Operator Implementation Plan

In addition to the need for operators to have access to ACO approved data packages (Compliance Documents), the AAWG also recognized the need for an Implementation Plan for operators to incorporate DT data from the Compliance Documents into the existing maintenance program. The incorporation of an Implementation Plan into a certificate holder's FAA-approved maintenance program is subject to approval by the certificate holder's Principal Maintenance Inspector (PMI) or other airworthiness inspector responsible for oversight of an operator.

2) DAH/Operator Work Split – Expected STG Activities

The Structures Task Group (STG) process as defined in Reference 3.i has been used successfully to implement aging airplane recommendations to model specific airplanes. These model-specific STGs will be used to support compliance with 14 CFR Parts 121.370a and 129.16. The model specific STG process should be initiated by the DAH well in advance so that Compliance Document will be available in time to facilitate the development of a Implementation Plan by individual operators. In order to initiate the STG process, the DAH will need to prepare some preliminary data for the STG to consider, including:

- Identify the airplane model(s) or airplane serial numbers that the DT data will be applicable to.

- Identify the fatigue critical structure.
- Identify the certification level.
- Identify existing DT data that supports compliance.
- Propose DT data that would need to be developed to support compliance.

The results of these preliminary tasks should be presented to the STG for discussion and agreement. This analysis should contain the rationale of the approach envisaged by the DAH to support compliance with §§ 121.370a and 129.16. It should clearly identify those existing DT data that already supports compliance (e.g. SRMs, RAGs, SBs, ADs), and where additional DT data should be developed. The results of these analyses will be part of the compliance document. The approach to develop these data should be presented, discussed and agreed as part of the STG.

The extent to which RAGs will be developed to cover the fatigue critical structure (versus case by case DTEs) should be addressed. Service feedback, presented by the operators, would be useful to support this discussion. How operators will be informed of the SRM updates and changes should be also discussed as part of the STG.

An implementation schedule for the development of DT data should be proposed by the DAH and agreed by the STG.

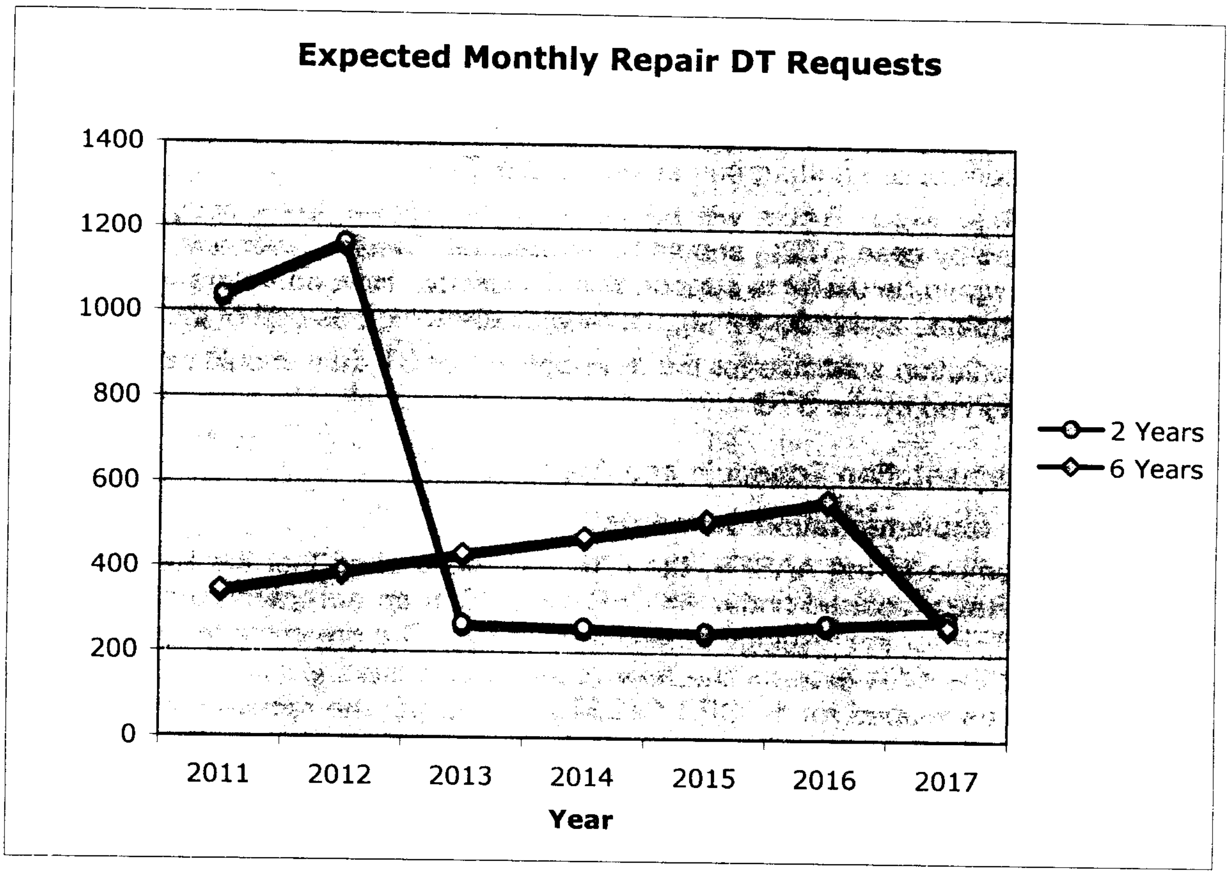
3) Implementation Schedule and Approach

a) Implementation Schedule

In the preamble to the AASFR, the FAA has established that the Repair Assessment Program (RAP) required under 14 CFR 121.370 is an accepted means of compliance for the AASFR for the fuselage pressure boundary. The preamble for the AASFR further states that the FAA expects the new repair assessment guidelines will be consistent with those developed for 14 CFR 121.370. Therefore, the requirements for developing and accomplishing damage tolerance inspections for repairs should not be more restrictive than the requirements for repairs on the pressure boundary, as required by 14 CFR 121.370.

The implementation schedule and approach outlined in AC 120-AAWG, for existing repairs, is patterned after the Repair Assessment Process given in AC 120-73, "Damage Tolerance Assessment of Repairs to Pressurized Fuselages". However, the AAWG has made a determination that the implementation program described in AC 120-73 most likely would not be able to be supported by the industry. The main reason is that a significant number of airplanes would be beyond the flight cycle DSG on December 20, 2010. This would create a situation where neither the operators, DAHs nor FAA could support the necessary surveys, data development requirements and maintenance program updates because of resource demands created by the expected volume of requests for the damage tolerance requirements for repairs (See Figure 2.1). If the AC 120-73 guidance (next C-check after effective date of the rule for airplanes beyond DSG) is used, the AAWG has estimated that over 750 airplanes (based on US Registered Airplanes active January 1, 2005) would require surveys within two years after December 20, 2010. It is estimated that this could create a backlog of as many as 37,500 repairs per year that requiring DT data whereas only 4500 repairs per year are estimated after the second year of the program. This would create an undue hardship for the industry and may in fact divert resources necessary for the continued airworthiness of aging fleets, resulting in decreased safety.

Figure 2.1 – Implementation Comparison AC 120-73 Versus AAWG Proposed Approach



The AAWG reviewed the data and has proposed a modified approach based on AC 120-73.

i. For airplanes below DSG on December 18, 2009, the proposal is to use the guidance provided by AC 120-73.

ii. For airplanes beyond DSG on December 18, 2009, it is recommended that airplanes are survey on a prorated basis within the established D-check time frame as defined by the Model Specific Structures Task Group. The purpose of prorating is to address the issues above and therefore the operators cannot be allowed to defer the implementation of the program until the end of the D-check time period. For example, if an operator had 30 airplanes over DSG on December 18, 2009 and was operating on a six year D-check equivalent, he would be required to inspect approximately 5 equivalent airplanes each year* until all of the airplanes were inducted into the program (*accounting for normal variations allowed by his Operation Specification). He should not be allowed to defer the required surveys until the end of the D-check or equivalent time period.

The AAWG, in making this recommendation, understands that it represents a change in the way past repair programs have been implemented. As the AAWG studied this issue they recognized that many factors supported an adjustment to the implementation approach. First, it is recognized that the Damage Tolerance Evaluation establishes a supplemental inspection program. That program supplements inspections that are already occurring by virtue of both normal and mandated maintenance programs, such as:

- Instructions for continued airworthiness
- Scheduled maintenance Programs
- SSIDs
- RAP
- Service Bulletins
- Corrosion Prevention and Control Programs

These programs have been effective in detecting repairs that require replacement because of detectable damage.

Second, programs such as the SSID and RAP were developed before a significant number of airplanes were subject to the regulations and therefore provided the industry a means to implement the rules. Those rules also were designed to address repairs that were the most significant to continued airworthiness (fuselage pressure boundary). Pre amendment 45 airplanes are under the requirements of §121.370 that requires operators to incorporate Repair Assessment Guidelines into their maintenance program for repairs to the fuselage pressure boundary. The recommended change in implementation does not affect the implementation program for repairs to the fuselage pressure boundary and only extends to repairs to other fatigue critical structure. For those airplanes certified to Amendment 45 or later, there are a certain number of airplanes that did not receive repairs with damage tolerance data for a period of time. The AAWG has recommended that a RAP type program be developed for the fuselage boundary repairs of those airplanes developed in accordance with AC 120-73. Those programs should be available to the operators on December 18, 2009.

b) Implementation Thresholds Based on DSG

Both AC 120-73 and the proposed AC 120-AAWG provide guidance material which establish the implementation times for accomplishing the repair assessment process as a percentage of the Design Service Goal (DSG) for an aircraft model. The DSG is defined as the period of time (in flight cycles/hours) established at design and/or certification during which the principal structure will be reasonably free from significant cracking. During the development of the Repair Assessment Program for pressurized fuselages, the STG's utilized this guidance to determine the implementation thresholds in flight-cycles that are contained in 121.370. A similar approach should be used for the development of the model-specific Compliance Documents; however, it should be noted that for certain portions of the fatigue critical structure, the rate of crack growth may be governed by flight hours rather than flight cycles. Therefore, these portions of the fatigue critical structure may have a separate implementation threshold given in flight hours.

c) Maintenance program escalation

The rule requires that operators incorporate the damage tolerance inspections and procedures into their maintenance program for all affected aircraft by December 20, 2010. In establishing a DT program, an operator may determine that the existing structural inspection program for a portion of the fatigue critical structure is sufficient to meet damage tolerance inspection requirements for repairs in that area. In this case, if an operator subsequently escalates the structural inspection program based on reliability data, it is the operator's responsibility to ensure that the new inspection interval is sufficient to meet damage tolerance inspection requirements for repairs in that area, or to establish a separate DT inspection task for those repairs. The FAA should ensure that PMIs, who are responsible for operator oversight of maintenance requirements, are aware of the requirements to review repair categories when escalations are requested.

4) Discussion on Adopted "DT" Phrases/Terminology used in the Rule and AC and what it means.

The Rule and AC uses several phrases to define various elements of Damage Tolerance. The purpose of these terms is to distinguish the different elements. There are four different terms used.

- Damage Tolerance Inspections and Procedures
- Damage Tolerance Data (DT data)
- Damage Tolerance Inspections (DTI)
- Damage Tolerance Evaluation Processes (DTE)

The term Damage Tolerance Inspections and Procedures is used in the 14 CFR 121.370a/129.16 rule language. This term is synonymous with the term Damage Tolerance Data (DT data) used extensively in the Advisory Circular.

Damage Tolerance Evaluation (DTE) refers to the process adopted as a means to develop Damage Tolerance Inspections (DTI). A DTE process could entail anything from a rigorous analysis methodology for use by a structures analyst to operator instructions that enable a survey and assessment of existing repairs to be made in a timely manner. And finally Damage Tolerance Data (DT data) refers collectively to the DTE processes and the DTI needed by an operator to address repairs as required by 14 CFR 121.370a/129.16.

5) Disposition and Recommendation Concerning AC 25.1529-1

a) Recommendations regarding the disposition of AC 25.1529-1

The AAWG recommends that AC 25.1529-1 be cancelled and the principal guidance be adopted into the proposed AC 120-AAWG. This proposal is made for two reasons. First, the guidance developed for AC 25.1529-1 uses language that is not uniformly applied and could be confusing. Second, AC 120-AAWG has been developed as the centerpiece for assessment of repairs on airplanes and all guidance material that is relevant should be contained in that document.

b) Three stage approach

Proposed AC 120-AAWG includes a three-stage procedure to gain approval of DT data for repairs. This is different than the two-stage approach contained in AC 25.1529-1. Industry practice, accepted by the FAA and EASA, currently allows a three-stage approach for development and approval of repair data. The three stages can be classified as:

1. Static Strength Approval and return to service
2. Establishment of threshold for inspection within twelve months of return to service
3. Establishment of repeat interval and inspection methodology, where necessary, before the threshold is reached.

The first stage is approval of the static strength data and the schedule for submittal of the DT data. Approval of the static strength component of the repair is required prior to return to service of the airplane. The schedule for the submittal of the damage tolerance data should be no later than 12 months following returned to service of the airplane.

The second stage of the process is the submittal and approval of the DT data that was scheduled in Stage 1. This data might only contain the threshold where inspections are required to begin. If this is the case, the submittal and approval of the remaining DT data may be deferred to the third stage. The operator should have a process in place to ensure that the remaining DT data is obtained and incorporated into his maintenance program before the established threshold.

The third stage is approval of any DT data not submitted in the second stage (typically repeat interval and inspection methodology). This data would need to be submitted and approved prior to the inspection threshold being reached. This would typically involve the inspection method and the repeat intervals.

c) Expectations concerning the control of DTI data within an operators maintenance program

Control of data within an operators maintenance program is crucial to maintaining the airworthiness of the airplane. Data to support a particular repair needs to be identified, tracked, and recorded to ensure proper accomplishment of the data requirements.

Operators are expected to have in place a Quality Control process to ensure proper application of approved data in the repair of an airplane.

i How is the data controlled

Operators are required by 14 CFR 121 to have a method to control data within their organizations. This method supports the requirements for return to service of an airplane after a repair. Included in these procedures are a means to provide detailed instructions to mechanics to perform the repair, track a repair, and schedule for inspection and re-inspection, if required.

(1) The operator should have a process that provides and controls the flow of data to ensure that accurate information is being supplied to mechanics performing the repair, that the data submitted for approval accurately depicts the repair, and a process to track the data when approved to ensure proper actions are taken such as inspections or replacements.

(2) The operator should have a process such as the continuing analysis and surveillance program to ensure that the repair data is being applied as approved, the person applying the repair is properly trained and qualified, and proper data and equipment are available to perform the repair. The quality control function would also ensure that after the repair is accomplished that it was done in accordance with the data that was approved for the repair. If inspections and repeat inspection are required, the quality control function would ensure that proper techniques are applied during the inspection and that if discrepancies are noted they are recorded for corrective action.

ii Tracking Process

A tracking process should be in place that would allow data developed for a repair to be distinguishable and identifiable as to the airplane applicability, techniques to be used, materials needed for the repair, and recording requirements to ensure retention of data.

Iii Task card revision and control

If a repair requires inspections or repeat inspections, the operator should have a process in place to develop repair documentation to record these inspections. This documentation may take the form of task cards that contain inspection criteria along with methods and equipment needed. It could take the form of a stand-alone engineering order or repair authorization that would contain similar information. The process should also have a method for maintaining the information on the documentation in a current state. If data approval changes inspection criteria, a revision process should be in place to acknowledge that change and revise the document to reflect the change.

6) Relationship between AC 91-56B, AC 120-73, AC 25.1529-1 and AC 120-AAWG

Several ACs provide guidance in establishing Damage Tolerance based maintenance programs for large transport category airplanes. The proposed AC for this tasking is yet another piece of guidance material that gives guidance on this subject. Whereas previous ACs provided guidance on specific issues, the proposed AC from this tasking utilizes and extends the concepts of the previous ACs for the purpose of establishing airplane level maintenance programs that are based on Damage Tolerance.

Three other ACs were previously published that provide information on Damage Tolerance Based Maintenance Programs.

AC 25.1529-1 – Provides guidance on the means by which repairs to SSID/P PSEs are evaluated for damage tolerance to allow a rapid return to service. This AC was written before the industry had developed an extensive expertise in performing damage tolerance assessments. The AAWG is recommending that this AC be cancelled and incorporated in part into AC 120-AAWG as an Appendix with significant changes.

AC 91-56B – Provides information on Aging Airplane Programs and specific guidance on the development of SSID/P programs. The AAWG has offered the FAA some recommendations on proposed changes to this AC under Paragraph 2.B.1 of this report. This AC is still valid and should be consulted for the development of new SSID/P programs. SSID/P programs develop damage tolerance based maintenance programs for the baseline as delivered primary structure of the airplane and can be used to show compliance to 14 CFR 121.370a/129.16.

AC 120-73 – Provide guidance on development of Repair Assessment Programs (RAP) for the Pressurized Fuselage Boundary. This AC was developed for the industry as a means to show compliance to 14 CFR 121.370, for eleven models of airplanes certified prior to Amendment 45 of 14 CFR 25. This AC is still valid and should be consulted for guidance on developing new RAP programs for any airplane. A RAP program developed under this AC can be used to show compliance to 14 CFR 121.370a/129.16 for the fuselage pressure boundary.

3. Task 2 – Evaluation of Alterations and Modifications for Damage Tolerance

A. Task 2 - Element 1 – Recommendations for Damage Tolerance Based Inspections of Alterations and Modifications

The AAWG was asked to review and comment on:

Prepare a written report assessing how an operator would include damage tolerance-based inspections and procedures for alterations and modifications made to aircraft structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure....

1) Introduction

For the purposes of the proposed AC and this report, the term "alteration" is used to describe a design change and encompasses the term "modification".

There are three categories of alterations that may be installed on a transport category airplane:

a) Supplemental Type Certificates (STCs) – these alterations are normally developed by persons other than the Type Certificate Holder (TCH). They are approved by the FAA under Subpart E of 14 CFR 21.

b) TCH alterations – these are alterations that are developed and approved by the TCH, either through an Amended Type Certificate approved by the FAA under Subpart I of 14 CFR 21, or through FAA-approved service documents such as Service Bulletins.

c) Individual alterations – these are alterations that are developed by and for an operator, which are approved through individual FAA Forms 8110-3 or other means acceptable to the Administrator.

The approach for damage tolerance-based inspections and procedures for alterations will be different for these three categories of alterations.

2) Types of Alterations to be Considered

Any alteration that directly affects the baseline fatigue critical structure must be evaluated regardless of the size or complexity of the alteration. This includes such alterations as SBs produced by the TCH and individual alterations for which an operator obtains FAA approval. The damage tolerance evaluation of an alteration must include both an evaluation of the newly created fatigue critical structure (i.e., does the alteration create new structure susceptible to fatigue cracking which could contribute to a catastrophic failure), and the interaction effects between the altered structure and the baseline fatigue critical structure. These interaction effects may not be limited to the area immediately surrounding the alteration; for instance, an alteration that includes a gross weight increase may significantly affect the magnitude and distribution of external loads on fuselage, wing, empennage, control surfaces, and landing gear structure.

Model Specific Airplane STG should establish a list of STC alterations that could be embodied on fatigue critical structure that should be considered on a model specific basis. The STG should consider the following list as examples of such alterations:

a) Passenger-to-freighter conversions (including addition of main deck cargo doors).
b) Gross weight increases (increased operating weights, increased zero fuel weights, increased landing weights, and increased maximum takeoff weights).
c) Installation of fuselage cutouts (passenger entry doors, emergency exit doors or crew escape hatches, fuselage access doors, and cabin window relocations).
d) Complete re-engine or pylon alterations.
e) Engine hush-kits and nacelle alterations.
f) Wing alterations such as installing winglets or changes in flight control settings (flap droop), and alteration of wing trailing edge structure.
g) Modified skin splices.
h) Any alteration that affects several stringer or frame bays.
i) An alteration that covers structure requiring periodic inspection by the operator's maintenance program.
j) An alteration that results in a change to the operational mission; e.g. significantly changes the manufacturer's load or stress spectrum (passenger-to-freighter conversion).
k) An alteration that changes areas of the fuselage that prevents external visual inspection, e.g., installation of a large external fuselage doubler that results in hiding details beneath it.

3) DAH and STG Activity

The AAWG recommends that the model-specific STG identify any STCs, which may be incorporated on a significant number of airplanes represented by the STG members. If such STCs are identified, the STG should invite the DAH for those STCs to attend and make presentations on the identified STCs and the status of any DT data for those STCs.

Chapter 2.C.2) of this Report describes the data which the DAH will need to provide to an STG to support the development of DT data for repairs. The same basic data will be necessary to support the development of DT data for alterations.

4) Operator/DAH Communication

For STC or TCH alterations, operators will need to contact the DAHs to determine if DT data exists for those alterations. There are three scenarios which are expected to occur:

a) The DAH No Longer Exists. In some cases, the STC may have been surrendered to the FAA.

b) The DAH Exists But Is Unable Or Unwilling To Develop The Data. An STC holder may not have the resources available to develop the data, or may be unwilling to commit the resources to do so. (Note: The FAA noticed (Reference 3.h) their intent to publish a new Subpart to 14 CFR 25 which would require DAHs to make DT data available to operators to support compliance with the AASFR. If this rule were promulgated, then this scenario would force the DAH to make a decision to either develop the data or to surrender the STC to the FAA.)

c) The DAH Exists And Provides The DT Data.

5) Recommended Timeline for Compliance

a) STCs

The AAWG has reviewed the various FAA regulations (SSID ADs) with respect to compliance requirements and timelines for development of DT data for STCs. Based upon that review; the following situations have been identified and need the development of specific timelines.

i) The DAH has developed DT data.

ii) The DAH has not developed DT data, and they will develop the data.

iii) The DAH has not developed the DT data, and they will not or cannot develop the data.

b) Alterations developed by a TCH

Alterations developed by a TCH may affect fatigue critical structure. The TCH should provide DT data for their alterations by December 18, 2009 in order to support operator compliance with the AASFR. The AAWG recommends that a standardized screening process for alteration SBs should be developed to identify which alteration SBs are affected by the AASFR.

c) Individual Alterations to fatigue critical structure

Individual alterations to fatigue critical structure are typically smaller in size, and the interaction effects are similar to those for a repair. An example of such an alteration may be an antenna that was installed and subsequently removed by a previous operator, but the structural reinforcement doubler was retained or a doubler similar to an SRM repair was installed. Such an alteration may have also been accomplished without issuing a formal STC or the records may be incomplete or missing. This scenario is most likely to occur on older, pre-amendment 45 airplanes and on alterations which were developed prior to the Changed Product Rule (14 CFR 21.101).

With respect to these type individual alterations to fatigue critical structures, the AAWG proposes to address them in the same manner as repairs for that model airplane. Therefore, they should be identified, assessed and categorized using the process given in the model-specific Compliance Document for repairs.

Figure 3.1 – Recommended Actions for Developing DT Data for STCs

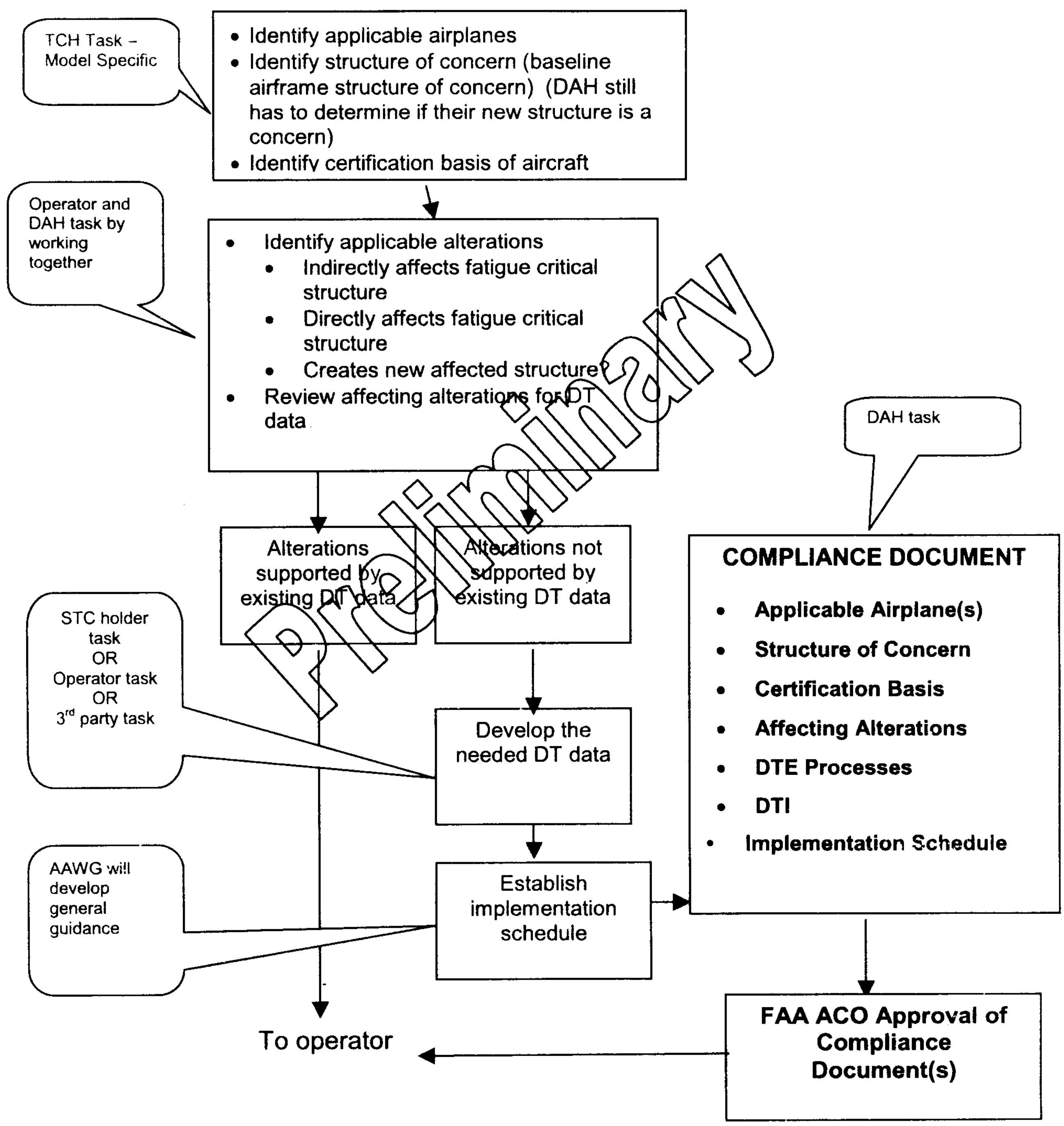
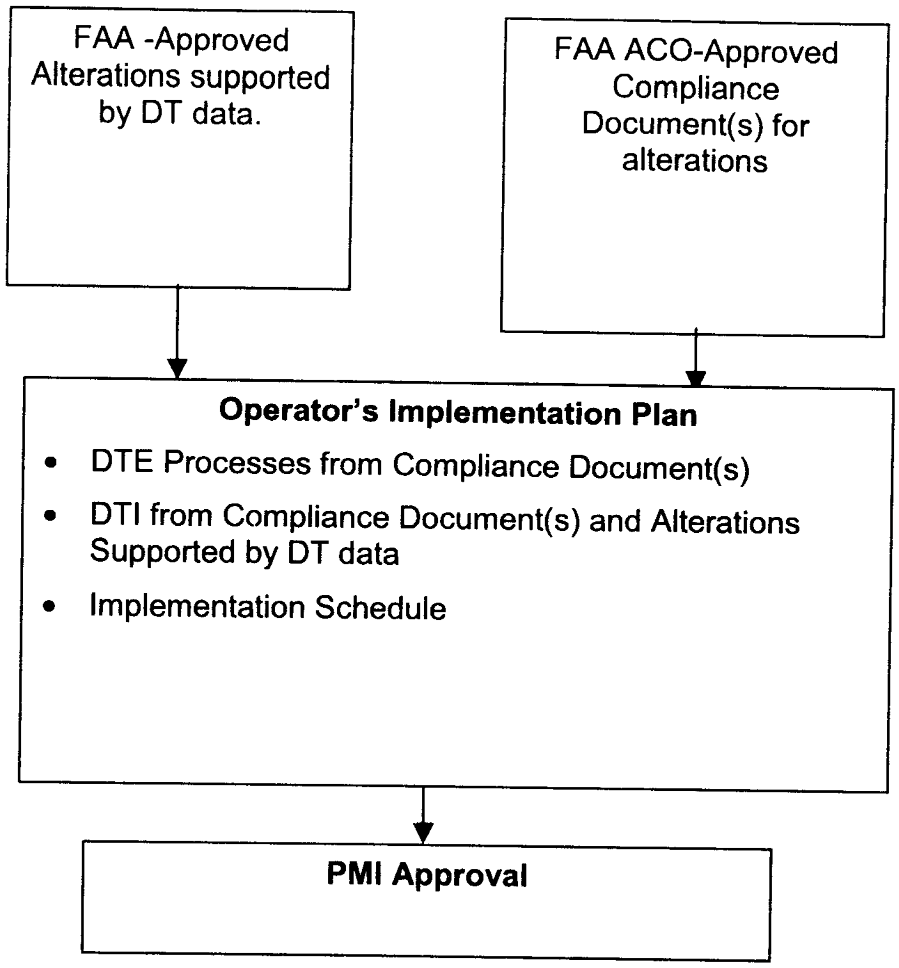


Figure 3.2 - Recommended Operator Action to Incorporate DT Data



B. Task 2 - Element 2 – Evaluation of Task 1 Recommendations on Repairs to Alterations

The AAWG was asked to review and comment on the following:

The report should also provide a recommendation on the means of compliance provided by the AC developed in Task 1 in regards to repairs installed on STC or ATC approved alterations and modifications.

This task element is interpreted by the AAWG to mean:

- Document the means of compliance developed for repairs to alterations in Task1.
- Determine if that means of compliance is applicable to alterations
- Document the AAWG's expectations for the STC DAHs.
- Propose changes to the AC as required.

The proposed AC 120-AAWG is intended to address all repairs to aircraft, including repairs to alterations and modifications. The proposed AC recommends that the DAH for the alteration develop a Compliance Document for repairs to the altered structure; the guidance is contained in Chapter 2 of the AC. The Compliance Document for repairs to the altered structure should contain:

- The applicability (airplane model(s), model variations, or serial numbers) of the alteration.
- An identification of fatigue critical structure that is unique to the alteration.
- The 14 CFR 25.571 certification level to be used.
- A review of existing DT data, if any.
- Development of additional DT data to support compliance. This could either take the form of RAGs or instructions to perform DTE on a case-by-case basis.
- An implementation schedule to bring existing repairs up to DT standards.
- FAA ACO approval of the Compliance Document for the alteration (by the FAA ACO having cognizance over the DAH).

The AAWG believes that the proposed AC 120-AAWG contains sufficient guidance for DAHs of alterations to develop a Compliance Document which would support operator compliance with the AASFR for repairs. As stated in Element 1 of Task 2, the STGs should identify DAHs that hold STC data that are of general interest to a Model Specific STG. The AAWG expects DAHs of such STCs to participate in the STG process and to advise the STG of the status of DT data, both for the STC itself and for repairs to the STC fatigue critical structure. The FAA has publicly noticed (Reference (3.h)) the fact that they are considering the issuing a rule to require DAHs to make available the necessary DT data in a timely fashion, to support operator compliance with the AASFR.

C. Task 2 - Element 3 – Evaluation of the Effectiveness of AC 91-56B for Alterations

The AAWG was requested to review the Draft AC 91-56B and assess its ability to provide the necessary guidance for an entity that is seeking compliance to 14 CFR 121.370a/129.16. In Task 2, the Tasking requests ARAC to do the following for alterations and modifications:

The ARAC should assess the effectiveness of AC 91–56B to provide guidance to STC holders for developing damage-tolerance-based inspections and procedures for alterations and modifications. The ARAC should do the following:

- ***Assess the effectiveness of AC 91– 56B to support Industry compliance with the AASIFR with respect to alterations and modifications.***
- ***Document any improvements to the AC that would provide better direction with respect to the guidance for STC holders in their development of damage-tolerance-based inspections and procedures for alterations and modifications.***

In Task 1, the ARAC was also requested to assess the effectiveness of AC 91-56B to provide guidance for an STC holder in seeking compliance with 14 CFR 121.370a/129.16 for repairs, and provide recommended changes. As stated in Section 3.B.1) of this Report where the topic for repairs was discussed, the overall findings and recommendations were the same for both alterations and modifications.

1) Discussion of Findings

In its review of Draft AC 91-56B, the AAWG made a determination that the guidance provided did not provide adequate directions for an entity seeking compliance to 14 CFR 121.370a/129.16. The changes incorporated into Draft AC 91-56B did not address a variety of technical and programmatic issues that an entity would need to address for compliance to the rule. The results of trying to follow the Draft AC would most likely resulted in a varying degree of compliance throughout the industry. In addition, there were significant differences between the Draft AC and the new FAA tasking contained in Federal Register Document 04-10816, dated 05-13-04. While the AAWG determined that Draft AC 91-56B would not be effective, it did view AC 91-56 as a top-level roadmap to the aging airplane programs that briefly describes the various programs and points to other ACs that provide specific guidance for each of the respective aging airplane programs. Therefore, in response to this the AAWG has developed a Draft AC 120-AAWG that provides guidance to both the DAH and the operator on an acceptable means of compliance to 14 CFR 121.370a/129.16.

2) Discussion of Proposed Changes to Draft AC 91-56B

On the basis of the above findings for Task 2, the AAWG also recommended changes to AC 91-56B with respect to alterations and modifications. These changes associated with Task 2 were included in Section 3.B.1) and Appendix C of this Report to avoid duplication or confusion.

D. Task 2 - Element 4 – Action Plan

The written report will include a proposed action plan to address and/or accomplish these recommendations, including actions that should be addressed in task 4.

1) Action Plan: Task 2 Guidance Material

a) The AAWG will prepare and submit guidance materials for consideration of alterations and modifications to the TAEIG within six months of TAEIG acceptance of the written report.

b) Upon TAEIG acceptance of the AAWG guidance material, the AAWG will recommend that Model Specific STGs invite STC DAH and involve them in the dialog to ensure that DT data is in existence on December 18, 2009 for all commonly embodied STCs.

2) Action Plan: Proposed Schedule for Completion of Guidance Material

a) AAWG complete Task 2 report and submit to TAEIG by December, 2005

b) The TCH will form Model Specific STGs where there is a significant need (e.g. Airplanes certified prior to 14 CFR 25, Amdt 54) by January 2006 to address Task 4 and begin the development of Model Specific Compliance Documents.

c) AAWG will review the Task 2 report recommendations and complete action with appropriate AC 120-AAWG changes within six months of TAEIG Task 2 report acceptance.

d) AAWG will submit the amended guidance material for TAEIG approval at the next scheduled TAEIG meeting.

e) Following TAEIG Acceptance of the guidance material and at the next meeting of the STG, the STGs should identify specific STC DAHs that hold STCs on the Model under consideration.

f) TCH, working with their STGs will identify a list of fatigue critical structure ASAP.

g) The FAA is considering the publication of Subpart I with requirements for STC DAHs to provide DT data. Based on the EAPAS NPRM it is anticipated that Subpart I will require the submittal of a compliance plan by the DAH. That compliance plan will require a time schedule of activities to insure that the required data is supplied on time.

h) According to the FAA Schedule for Subpart I, STC DAHs will be required to submit the compliance plan within 90 days of the effective date of the final rule. At this point it will be apparent which STC DAHs will be providing DT data for the STCs they own.

i) DAHs should complete DT data for STCs, ATCs, SBs, etc. by December 2009. This date may change dependant upon the FAA's rulemaking for a Part 25 rule to require DT data.

j) Operators to incorporate DT data for STCs, ATCs, SBs, etc. by December 20, 2010, if available

k) Operators to submit plan to obtain FAA approved DT data for STCs, ATCs, SBs, etc. which have no DT data to cognizant PMI as part of the implementation plan submitted for compliance to 14 CFR 121.370a/129.16.

4. Task 3 – WFD Considerations for RAMs

A. AAWG Position Regarding the Assessment of WFD for Repairs, Alterations and Modifications:

The analysis of a RAM for WFD provides additional needed information concerning the maintenance program requirements to maintain the continued airworthiness of the airplane. Specifically it will either validate the inspection program established for fatigue related cracking or it would provide inspections that are more stringent and/or establish a removal limit for the RAM.

As part of a WFD evaluation, it was determined that the following two categories of RAMs should be addressed: RAMs susceptible to WFD; and RAMs to areas where the baseline structure is susceptible to WFD. For the latter category, a WFD evaluation is carried out for the baseline structure to establish the appropriate maintenance actions. A RAM in this area may have a repercussion on these maintenance actions. For instance, an STC may affect the stress level on a lap joint, and invalidate the maintenance actions that have been defined to preclude WFD in this lap joint. Therefore, WFD actions for baseline structure should be defined prior to requiring an assessment of the effect of the RAM.

B. Task 3 - Element 1 – Recommendations for WFD of RAMs

The AAWG was asked to consider the following in regards to WFD of RAMs:

Provide a written report providing recommendations on how best to enable part 121 and 129 certificate holders of airplanes with a maximum gross take-off weight of greater than 75,000 pounds to assess the WFD characteristics of structural repairs, alterations, and modifications as recommended in a previous ARAC tasking.

1) 2001 ARAC Recommendations Regarding WFD

In May 2001, ARAC recommended (See Reference (3.b)) that large transport category airplanes have new operational rules enacted that would assure that fatigue cracking that could lead to a WFD condition would be detected and corrected in a timely fashion. Two operating requirements were proposed by ARAC for each operational rule part. The first established a "Limit of Validity" of the maintenance program and the second established a requirement for structural maintenance programs that considered the aspect of preventing WFD in the fleet. In the near future, it is expected that the FAA will release these operational rules with some modifications based on the requirements of the AASFR and other rules that are currently being considered.

Appendix C contains a copy of the NPRM submitted by ARAC on the subject of WFD. For the purposes of reference, the following is a synopsis of the intent of the proposed operational rules.

Operational Rule 1 – Basis of Structural Maintenance Program

The first operating rule, entitled "Basis of Structural Maintenance Program," would prohibit the operation of transport category airplanes greater than 75,000 pounds (maximum takeoff gross weight) unless the ALS of the ICA that includes the flight cycle or flight hour limits of validity of the structural maintenance program is incorporated in its maintenance or inspection program within 12 months after the effective date of the proposed rule. Regardless of the certification basis, the initial limit of validity chosen must ensure that WFD is precluded from the fleet up until the limit has been reached by that airplane.

Acceptable elements of the current aging aircraft program would be included or referenced in the ALS of the ICA. The following is a summary of the current aging aircraft structural maintenance program:

1. Acceptable mandatory modifications programs are those programs that have reviewed all relevant service bulletins and have produced a document that lists those service bulletins with applicable terminating modifications that has been mandated by an airworthiness directive. Not all of the terminating modifications are in a single document. There may be airworthiness directives that mandate terminating modifications for individual service bulletins.

2. An acceptable CPCP includes those CPCP documents that were mandated by airworthiness directives. The CPCP mandated by airworthiness directives should be referenced in the ALS of the ICA. Also, for airplanes certified to the damage tolerance requirements at or after amendment 25-54, and for those operators that have incorporated a maintenance program in accordance with MSG-3, Revision 2, an acceptable CPCP is found in the MRB document for those items listed under environmental damage

(ED). (As indicated previously, the FAA is considering additional rulemaking to require that maintenance or inspection programs for transport category airplanes include an FAA approved CPCP.)

3. An acceptable SSIP includes those SSIDs developed in accordance with AC 91-56 that are mandated by ADs. Those mandated SSIDs would be referenced in the ALS of the ICA. Also, an acceptable SSIP would be the ALS of the ICA itself, for those airplanes certified to the damage tolerance requirements at or after Amendment 25-54. Also the "Aging Airplane Safety" rule will require damage tolerance-based SSIPs be required 4 years after the effective date of the proposed rule.

4. An acceptable RAP for the fuselage pressure boundary is found for the 11 original "aging models" listed in §§ 91.410, 121.370, 125.248, and 129.32. Airplanes certified to the damage tolerance requirements at or after Amendment 25-45 should have acceptable repair assessment programs. As part of their certification basis, operators should be assessing repairs for damage tolerance. The Aging Airplane Safety Final Rule will require some operators to develop damage tolerance based supplemental inspections for all major repairs, alterations and modifications to baseline structure within 4 years after the effective date of the rule.

Operational Rule 2 – Aging Aircraft Program

The second operating rule, entitled "Aging Aircraft Program (Widespread Fatigue Damage)," would require a three-part compliance:

First, for baseline structure, this proposed rule would prohibit the operation of certain transport category airplanes greater than 75,000 pounds (maximum takeoff gross weight) beyond the flight cycle limits shown in its ALS of the ICA, or 12 months after the effective date of the proposed rule, whichever occurs later, unless a structural maintenance program is incorporated within its maintenance or inspection program. This new program must include inspections and/or modification/replacement actions to the baseline structure for prevention of WFD. The baseline structure is defined as that airplane structure that was originally built by the DAH.

Second, for structure with existing repairs or alterations, this proposed rule also would prohibit operation of certain transport category airplanes greater than 75,000 pounds (maximum takeoff gross weight), 48 months after initial incorporation of the structural maintenance program for the baseline structure or 48 months beyond the time that the airplane has accumulated the flight cycles shown in the limit of validity manifested in its ALS of the ICA, whichever occurs later, unless a structural maintenance program is incorporated within its maintenance or inspection program. This new program must include inspections and/or modifications/replacement actions for repairs, alterations, or modifications susceptible to MSD/MED or repairs, alterations or modifications that affect baseline structure that is susceptible to MSD/MED accomplished prior to the effective date of this proposed rule for the prevention of WFD. The new structural maintenance program must be approved by the FAA ACO or office of the TAD, having cognizance over the type certificate for the affected airplane. The proposed rule would specify that certain tasks would need to be accomplished within the noted 48-month time frame, including:

- Within six months, operators establish a plan to address repairs, alterations and modifications, which includes identification of interim inspections of applicable repairs, alterations, and modifications. Each operator submits that plan to the FAA ACO or office of the TAD through the operator's PMI.
- Within six months after receipt of the plan, the FAA ACO or office of the TAD approves the plan if it is acceptable.
- Within six months after receipt of the FAA approved plan, each operator incorporates interim inspections of applicable repairs, alterations, and modifications identified in the plan.
- Within 36 months after initial incorporation per paragraph (a) or within 36 months beyond the time that the airplane has accumulated the flight cycles or flight hours shown in the limit of validity manifested in its ALS of the ICA, whichever occurs later, each operator submits the structural maintenance program to the FAA ACO or office of the TAD through the operator's PMI.

- *Within six months after receipt of the structural maintenance program, the FAA ACO or office of the TAD approves the program if it is acceptable.*
- *Within 48 months after initial incorporation per paragraph (a) or within 48 months beyond the time that the airplane has accumulated the flight cycles or flight hours shown in the limit of validity manifested in its ALS of the ICA, whichever occurs later, each operator incorporates the FAA approved program into its maintenance program.*

Third, for new repairs and alterations (installed after effective date of this NPRM), the proposed rule also would prohibit operation of certain transport category airplanes, greater than 75,000 pounds (maximum takeoff gross weight), 18 months after a repair, alteration or modification susceptible to MSD or MED or a repair, alteration or modification that affects baseline structure that is susceptible to MSD or MED is accomplished on or after the effective date of the rule, unless an appropriate threshold for inspection and/or replacement is incorporated within its maintenance program. This new program must include a threshold where inspections and modification/replacement actions to said repair, alteration, or modification must be incorporated to preclude WFD. The new structural maintenance program must be approved by the FAA ACO or office of the TAD, having cognizance over the type certificate for the affected airplane. The following requirements are to be accomplished at the times noted below:

- *The static strength approval of the repair, alteration, or modification is to be accomplished before further flight.*
- *Within 18 months of the static strength approval, a damage-tolerance analysis that includes a WFD analysis of the repair, alteration or modification is approved by the FAA ACO or office of the TAD, which defines the threshold for inspections and/or modification/replacement actions is included in the operators FAA approved structural maintenance program.*
- *Within 24 months before reaching the threshold, specific FAA approved inspection methods and repeat intervals are incorporated for each repair, alteration or modification into the FAA approved structural maintenance program.*

2) Discussion of ARAC Recommendations

The ARAC recommendations for prevention of WFD were developed using the concept of a stand-alone audit of the baseline structure and any repairs, alterations and modifications that might have been performed. With the advent of the Aging Airplane Safety Final Rule in February 2005, the ARAC recommendations, while still being valid, need some reconsideration from both a technical and a managerial point of view. In addition, airplanes certified to later amendment levels of 14 CFR 25 may meet the WFD requirements during certification. With this in mind, the AAWG would like to extend and adjust the 2001 recommendations accordingly.

The 2001 ARAC recommendations stipulated a rather elaborate operator based means to develop and incorporate inspections into maintenance programs for WFD considerations for RAMs. The AAWG has reviewed this means and has determined that the AASFR provides a more convenient means of accomplishing the development of maintenance programs for RAMs that will preclude the development of WFD.

Specifically the determination of any maintenance actions required to preclude WFD should be done in context of the procedure established in the AC for determination of the damage tolerance requirements for the RAM. Such requirements are determined during Stage 3 of the review process for repairs. This is a natural place to determine all future maintenance requirements for the RAM including WFD. In the context of the AC, this procedure supports both new and existing RAMs.

For new RAMs, additional work is required on the part of the DAH. The DAH should consider updating any significant published documents like the SRM, RAP and or Structurally Significant Service Bulletins to include information relative to maintenance requirements for WFD.

Finally, the 2001 ARAC recommendations also recommended the establishment of a Limit of Validity (LOV). This LOV establishes a point in the operational life of the airplane where the maintenance program as contained in the ICA of the airplane for continued airworthiness is no longer supported by existing OEM engineering data. The ARAC recommends that operation of the airplane be halted at this point until new engineering data is developed to support the continued airworthiness. The LOV is applicable to both the baseline structure and any RAMs that may have been embodied.

a) 2005 AAWG Recommendations on WFD

The AAWG was specifically tasked to consider how best to assess the WFD characteristics of RAMs on the continued airworthiness of airplanes with a maximum gross takeoff weight of greater than 75,000 pounds. This includes all large transport category airplanes in service today.

The AAWG's original recommendations came with guidance information that allowed operation of the airplane up to DSG before a WFD assessment of the baseline structure was required for the airplane. This recommendation was written primarily for airplanes certified to 14 CFR Amendment 45 and earlier yet the AAWG believes that this is also appropriate for all post amendment 45 airplanes where a two-lifetime fatigue test was performed. The question is when is it appropriate to assess RAMs for WFD. The AAWG considered this question and determined that in all cases, assessment of a RAM for WFD should be done after the assessment of the baseline structure especially if the RAM was evaluated for Damage Tolerance and is under a continued airworthiness program. With respect to WFD for RAMs, the AAWG believes the following to be an appropriate program to enact:

- For those airplanes that need a survey to address DT for repairs, the WFD assessment should occur at the same timeframe (action and implementation plan)
- For newer airplanes that only need WFD for repairs (e.g. 14 CFR Part 25 Amdt. 54 and beyond), the WFD action should occur when the airplane reaches DSG
- For newer airplanes that only require WFD for alterations (e.g. 14 CFR Part 25 Amdt. 96 and beyond) the WFD action should occur at RAM certification

Further, the 2001 Recommendations failed to establish a means to implement the program. While all of the requirements were there, the mechanics of what needed to be done was lacking. Therefore, the AAWG believes that the following is appropriate to insure the timely handling of the WFD issues for both the baseline structure and any embodied RAMs. The actions discussed below should be in place and scheduled for completion for all affected airplanes by December 2010.

The AAWG envisions that the requirement will be addressed through the submittal of a plan by December 2009 that delineates the following DAH actions as developed within the STG activities:

i. Definition of the LOV for All Large Transport Category Airplanes with Maximum Gross Takeoff Weights greater than 75,000 pounds.

  (1) DSG, or
  (2) Other limit with rationale and/or a list of required actions (existing or underdevelopment)

ii. A schedule, dependent on 14 CFR 25 Certification Amendment as discussed above, for completion of the following:

  (1) A review of Published Service Information (SRMs, SBs, Service Letters, etc.) with-respect-to WFD and propose service action to achieve the initial LOV, if required.
  (2) Guidelines for determining which repairs and alterations need to be assessed for WFD.
  (3) Model specific implementation program, including:
    (a) Timeframe and actions required for when to review repairs and RAMs for WFD.
    (b) - STCs/ATCs are assessed for WFD (includes Baseline Structure of the STC/ATC and surrounding fatigue critical structure).

iii. Expected Timeframe for action would be in accordance with the 14 CFR 25 Amendment Level of the airplane under consideration as Depicted in the Table 4.1.

TABLE 4.1 – WFD REQUIREMENT BY CERTIFICATION LEVEL

	14 CFR 25 / 25.571 Applicable Amendment			
ISSUE	**Pre Amdt 45**	**Amdt 45**	**Amdt 54 to 86**	**Amdt 96**
Establishment of LOV	Dec 2009	Dec 2009	Dec 2009	Dec 2009
WFD Baseline	121.WFD	121.WFD	121.WFD	T.C.
DT RAMs-AASFR	Survey*	Survey* & T.C.	Survey* and/or T.C.**	T.C.
WFD RAMs	Concurrent with DT Survey*	Concurrent with DT Survey*	Survey Similar to one like the DT req.	T.C.

* Survey means Survey conducted per the AASFR Implementation Plan
** STG will decide if Survey is necessary

Note: Once the Limit of Validity is reached, the airplane can no longer be operated unless that original Limit of Validity is extended with appropriate new service actions.

This plan would be submitted to the ACO for approval.

The Table 4.2 further explains when a repair or alteration would receive an assessment for WFD. The information contained in this chart is preliminary and subject to further discussion and may differ in the final proposal developed in the Task 3 follow-on activity.

TABLE 4.2 – PROPOSED TIMELINE FOR DEVELOPING DT AND WFD MAINTENANCE REQUIREMENTS

<table>
<tr><th colspan="5">Timelines for Obtaining DT and WFD Assessments for Repairs and Alterations</th></tr>
<tr><th colspan="2"></th><th>REPAIRS</th><th colspan="2">ALTERATIONS</th></tr>
<tr><td rowspan="3">DT</td><td>Existing</td><td>75% DSG*</td><td colspan="2">By Dec 18, 2009 (if DAH support) OR plan in place to get data or other action within 4 yrs from Dec 18, 2009 (if no DAH support)</td></tr>
<tr><td rowspan="2">New</td><td rowspan="2">3 stage**</td><td>New cert. new instl</td><td>DT required prior to certification today (Recommendation)</td></tr>
<tr><td>Old cert. new instl</td><td>DT required on all installations after Dec 20, 2010</td></tr>
<tr><td rowspan="4">WFD</td><td>Existing</td><td>75% DSG*</td><td colspan="2">By Dec 18, 2009 (if DAH support) OR plan in place to get data or other action within 4 yrs from Dec 18, 2009 (if no DAH support)***</td></tr>
<tr><td>New Cert prior to Amend 45</td><td>3 Stage** Accomplished at time of DT assessment clear repair to operational limit</td><td colspan="2">3 stage** Accomplished at time of DT assessment clear alteration to operational limit</td></tr>
<tr><td>New Cert Amend 45 to 95</td><td>At DSG 3 Stage**</td><td colspan="2">At DSG 3 Stage **

Operators concerned that this may require a tracking or survey of their airplanes at DSG

Airbus concerned that the requirement for WFD does not exist for these airplanes and that the baseline structure has not yet been evaluated for WFD, why consider repairs and alterations</td></tr>
<tr><td>New Cert At Amend 96 and Above</td><td>3 Stage** Accomplished at time of DT assessment clear repair to operational limit</td><td colspan="2">3 Stage** Accomplished at time of DT assessment clear alteration to operational limit</td></tr>
</table>

*75% DSG really means .....
Stage 1 @ 75% DSG
Stage 2 within 12 months from stage 1
Stage 3 just prior to (I)
Refer to App. 5 for details

**3 stage means what App. 4 says....
Stage 1 @ time of installation
Stage 2 within 12 months (DT, not WFD?)
Stage 3 just prior to (I), included DT & WFD

*** Requirement is to identify any maintenance actions required for WFD to DSG or LOV

b) Technical Considerations

The AAWG still supports the technical recommendations given to ARAC and the FAA in May 2001. This includes the establishment of a Basis for the Structure Maintenance Program and a definition of a "Limit of Validity" (LOV) or equivalent. The AAWG also supports a timely audit of the baseline structure and any repairs, alterations and modifications to define any required changes or additions to the structural maintenance program to preclude the occurrence of WFD.

While ARAC spent a considerable amount of time developing and confirming the WFD methodology for the baseline structure, comparably little time was spent on how that methodology would perform on repairs, alterations and modifications. It is now apparent that some further technical considerations with appropriate guidance need to be developed to prevent development of WFD in RAMs.

To facilitate the development of the data necessary for compliance to the rule, the following needs to be established:

i. Repair configurations that are susceptible to WFD
   (1) Size effect
      e.g. large doubler repairs (bigger than 1 frame bay two stringer bays)
   (2) Multiple site
      Repairs at the same location at multiple parts (e.g. stringers at the same frame station)
   (3) Interaction of different repairs
      Blend out near a doubler repair (stress increase due to two different reasons)

ii. Development of maintenance program parameters.

A major difference between RAMs and baseline structure is the level of associated test evidence. Whereas the baseline structure is almost fully represented in full-scale tests, RAMs may only be installed in selected areas. As a result, RAMs are typically justified by analysis methods that have been proven by tests rather than tests themselves. Guidance material is needed on how to adjust the factors associated to the determination of the Inspection Start Point (ISP) and the Structural Modification Point (SMP) to account for the lack of test evidence.

Further, a number of methods of analysis proposed for WFD account for the number of airplanes in the fleet in the determination of ISP and SMP. RAMs on the other hand may be unique to one airplane, or a limited number of airplanes making the use of fleet data difficult. Further the time those RAMs were embodied on an airplane would vary and their respective lives would likewise be difficult to characterize. Guidance is needed on how to appropriately handle such situations.

c) Program Management Considerations

i. Both new and existing RAMs should be assessed for WFD in the same time stipulated in the AC for DT. This means the three stage approach:

(1) Stage 1 – Clearance for Static Strength and return to flight
(2) Stage 2 – Within twelve months the establishment of a threshold for inspections
(3) Stage 3 – Twenty-four months before the threshold development of inspections and/or replacement times to maintain continued airworthiness when fatigue cracking is likely. Stage 3 contains consideration for development of WFD.

ii. Existing DAH documents, like the SRM and RAP, should be updated to include consideration for WFD damage scenarios by December 18, 2009 to support compliance to 121.WFD where operation past DSG is defined.

iii. The entities that are responsible for the development of data to support the three stage approach is as follows:

(1) Baseline structure to be supported by the OEM
(2) STCs to be supported by the STC holder
(3) RAMs done by a DAH to be supported by the DAH
(4) Where the DAH or STC holder no longer is in a position to support the development of the data, the certificate holder is responsible for the development.
(5) The time WFD should be assessed: Guidance should be developed that specify that WFD inspections should be incorporated into the maintenance planning beyond DSG at the threshold determined in Stage 2.

C. AAWG Recommendations

1) WFD for baseline structure should be accomplished prior to WFD for RAMS
2) With respect to WFD for RAMs
   a) For those airplanes that need a survey to address DT for repairs, the WFD actions should occur at the same timeframe (action and implementation plan)
   b) For those newer airplanes that only need WFD for repairs (e.g. part 54-96), the WFD action should occur at a timeline dependent upon when the airplane reaches DSG
   c) For those newer airplanes that only require WFD for alterations (e.g. Amdt. 54-96) the WFD action should occur at DSO.

3) Both new and existing RAMs should be assessed for WFD in the same time stipulated in the AC for DT. This means the three stage approach:
   a) Stage 1 – Clearance for static strength and return to flight
   b) Stage 2 – Within twelve months the establishment of a threshold for inspections
   c) Stage 3 – Twenty-four months before the threshold development of inspections and/or replacement times to maintain continued airworthiness when fatigue cracking is likely. Stage 3 contains consideration for development of WFD.

4) Existing DAH documents, like the SRM and RAP, should be updated to include consideration for WFD damage scenarios by December 18, 2009 to support compliance to 121.WFD where operation past DSG is defined.

5) The entities that are responsible for the development of data to support the three stage approach is as follows:
   a) Baseline structure to be supported by the OEM
   b) STCs to be supported by the STC holder
   c) RAMs done by a DAH to be supported by the DAH
   d) Where the DAH or STC holder no longer is in a position to support the development of the data, the certificate holder is responsible for the development.

   To facilitate the development of the data necessary for compliance to the rule, the following should be established:

   e) Repair configurations that are susceptible to WFD
      i. Size effect
         e.g. large doubler repairs (bigger than 1 frame bay two stringer bays)
      ii. Multiple site

Repairs at the same location at multiple parts (e.g. stringers at the same frame station)

iii. Interaction of different repairs
Blend out near a doubler repair (stress increase due to two different reasons)

6) Development of WFD data.

A major difference between RAMs and baseline structure is the level of associated test evidence. Whereas the baseline structure is almost fully represented in full-scale tests, RAMs may only be installed in selected areas. As a result, RAMs are typically justified with analysis methods that have been proven by tests rather than tests themselves. Guidance material is needed on how to adjust the factors associated to the determination of ISP and SMP to account for the lack of test evidence.

Further, a number of methods of analysis proposed for WFD take into account the number of airplanes in the fleet in the determination of ISP and SMP because the details under examination exist on every airplane in that fleet. RAMs on the other hand may be unique to one airplane or a limited number of airplanes and may have significantly different lives than the airplanes themselves. Guidance is needed on how to appropriately handle such situations.

7) The time WFD should be assessed:

Guidance should be developed to specify that WFD inspections should be incorporated into the maintenance planning beyond DSG at the threshold determined in Stage 2.

D. Task 3 - Element 2 – WFD Action Plan

The written report will include a proposed action plan to address and/or accomplish these recommendations including actions that should be addressed in task 4 below.

1) Action Plan: Task 3 Guidance Material

Upon acceptance by ARAC of the recommendations above, the AAWG will establish a group of technical experts that will develop the required technical basis for the guidance material. They will then develop that material for inclusion in either FAA Advisory Circular 120-AAWG or another, yet to be determined, AC.

It is important that the guidance material will enable the STGs and individual operators to develop the required data to support operator compliance. The following is appropriate to consider when looking at both the guidance material and the operation of the STGs.

- **a)** Screening process to identify significant STCs. The guidance material should contain a means to screen STCs to determine which ones would be of a potential concern for development of WFD.
- **b)** Developing means to acquire data for significant STCs where the DAHs are not in a position to supply the data. There will be some STCs where the DAH is unavailable to develop the data. The STG should develop a plan whereby the data is developed.
- **c)** There may be other actions that could be considered to assist the operators in developing the data.

2) Action Plan: Proposed Schedule for Completion of Guidance Material

The AAWG will complete this additional work within six months of the acceptance of the recommendations by ARAC.

A key element of the schedule is the inclusion of an invitation to significant STC holders to participate in the STG. An invitation should be extended to those DAHs who hold the certification data for STCs identified in step one. Their participation in the STG will be of great assistance in developing the required data.

5. Task 4 – Model Specific Programs

The DAH should complete the framework of a Compliance Document by December 20, 2008 for each affected model and that document should include the identification of fatigue critical structure and the means by which repairs are to be addressed (both existing and future repairs). This document will have within it the methods to be employed in the assessment but may not contain some of the required data such as updates to the SRM and any model specific RAGs. The SRM updates and any model specific RAG documents should be published by December 18, 2009. Once the SRM updates and any RAG documents are published and referenced in the Compliance Document, this document will be presented to the FAA ACO for approval. Following approval, the Compliance Document will form the basis for certificate holder compliance for repairs to the as delivered OEM structure to 14 CFR 121.370a/129.16.

6. Conclusions and Recommendations

Compliance with the new Aging Airplane Safety Final Rule, 14 CFR 121.370a and 129.16 will require operators and DAHs to cooperatively develop data that, in some cases, does not currently exist. The AAWG recommends that this be accomplished through model specific STGs for both baseline structure as well as for repairs, alterations and modifications. Operators of applicable airplanes must have this data to show compliance by December 20, 2010. To this end, all updates to existing data should be published by December 18, 2009.

Task 1 & 2 Conclusions and Recommendations (Repairs and Alterations/Modifications)

Even though 14 CFR 121.370a and 129.16 could be construed to be applicable to repairs alterations and modifications to composite structure, the AAWG did not specifically develop guidelines for this particular type of structure. There were three principal reasons for this: (1) there is not a significant amount of composite primary structure on airplanes today; (2) most of that structure is on airplanes that were certified to Amendment 45 or later; and (3) the certification process in regards to damage tolerance for composite structure is significantly different than that of metallic structure and are adequately covered by AC 20-107A.

The AAWG developed draft AC 120-AAWG to document the process for assessing repairs to fatigue critical structure. The proposed AC addresses repairs to both baseline structure as well as repairs to alteration and modifications. The AAWG believes that the proposed AC 120-AAWG contains sufficient guidance for DAHs to develop a Compliance Document which would support operator compliance with the AASFR for repairs.

Key to completing this process is the identification of fatigue critical structure for each applicable airplane model. Repairs to the fatigue critical structure will need to be assessed for damage tolerance. Depending on the certification level of the aircraft model and whether installed repairs are already covered by DT data, this may require a survey of the aircraft.

The conclusions and recommendations (***Bold Italicized Text***) from the AAWG tasking regarding repairs and repairs to alterations are documented in Sections 3 through 5 of this report. These are summarized below.

1. SSID programs and ALS were developed to address the un-repaired fatigue critical structure and do not consistently provide instructions for repairs to that structure.

2. The AAWG recommends that existing SBs, SRM, SSID programs and ALS programs for each applicable airplane be reviewed and updated to include DT data for all repairs to fatigue critical baseline structure as well as repairs to alterations and modifications by December 18, 2009.

3. The AAWG concluded that there are repairs and modifications to structural components susceptible to fatigue contained in the AMM and/or CMM and that these repairs and modifications are not under the same level of scrutiny that other repairs are subjected to.

4. The AAWG recommends that the FAA issue additional tasking to the ARAC to investigate the status of the AMM and CMM, and make appropriate recommendations.

5. The AAWG concluded that the development of RAG documents for the fuselage pressure boundary (fuselage skin, door skins, and bulkhead webs) provides vital information for operators to comply with 14 CFR 121.370 and 129.32 for the applicable airplanes.

6. The AAWG recommends that a generalized RAP program (includes greater coverage of fatigue critical structure than the pressurized boundaries) be considered and developed, if technically and economically feasible.

7. For those airplanes certified to Amendment 45 or later, where repairs to the fuselage pressure boundary were not provided with DT data, it is recommended that a Fuselage RAP program be developed in accordance with the guidance provided in AC 120-73, where economically feasible.

8. The AAWG recommends that the TAEIG task the AAWG to revise AC 120-AAWG to include a process for developing damage tolerance based maintenance inspections for alterations and modifications. A copy of the proposed tasking is included in Appendix E of this report.

9. The AAWG reviewed draft AC91-56B and made the determination that the guidance material does not provide adequate directions for an entity seeking compliance to AASFR.

10. The AAWG recommends that AC 91-56B be revised as delineated in Sections 2 and 3 of this report. A full draft of a proposed revision of AC 91-56B is included in Appendix C.

11. The AAWG reviewed AC 25.1529-1 and determined that the guidance material would not support compliance to the AASFR and further did not follow industry-accepted practice.

12. The AAWG recommends that AC 25.1529-1 be cancelled and incorporated in pertinent part into the proposed AC 120-AAWG.

13. The AAWG Recommends that AC 120-AAWG be promulgated as a means of compliance to 14 CFR 121.370a and 129.16 with respect to repairs. A copy of this AC is contained in Appendix B.

<u>Task 3 Conclusions and Recommendations (WFD for RAMs)</u>

14. For WFD evaluation, the AAWG concluded that the following two situations should be addressed:

a. The structural configuration of the RAM itself, if it is susceptible to WFD;

b. The effect of the RAM on baseline structure susceptible to WFD.

15. WFD actions for baseline structure should be defined prior to requiring an assessment of the effect of the RAM.

16. The determination of any maintenance actions required to preclude WFD should be done in context with the procedure defined in AC 120-AAWG for determination of the damage tolerance requirements for the RAM:

a. For those airplanes that need a survey to address DT for repairs, the WFD assessment should occur within the same timeframe (action and implementation plan;

b. For newer airplanes that will require WFD analysis for repairs and alterations, (e.g. 14 CFR Part 25 Amdt. 54 and beyond), the WFD action should occur when the airplane reaches DSG

c. For newer airplanes that only require WFD for alterations (e.g. 14 CFR Part 25 Amdt. 96 and beyond) the WFD action should occur at certification

17. Existing DAH documents, like the SRM and RAP, should be updated, in a timely fashion, to include consideration for WFD damage scenarios to support compliance to 121.WFD, where operation past DSG is defined.

18. To complete Task 3, the AAWG recommends that the TAEIG task the AAWG to assemble a group of technical experts for the development of the required technical basis on how to address WFD for RAMs. The work product of this activity would be material for inclusion in either FAA Advisory Circular 120-AAWG or yet another, to be determined, AC. A copy of the proposed Tasking is included in Appendix E of this report.

Task 4 Conclusions and Recommendations (Model Specific Programs)

19. The AAWG concurs with the ARAC Tasking in that it should oversee the timely development and implementation of model specific Compliance Documents and new and updated model specific data to support operator compliance.

20. The AAWG concurs that model specific STGs should be formed to identify the fatigue critical structure, and review existing data that could be used in support of compliance with the AASFR and that the AAWG oversee that activity.

21. The AAWG concluded that the cooperation of the Type Certificate Holders and the Design Approval Holders is necessary for operators to be able to comply with the AASFR.

22. The AAWG recommends that the DAH Model Specific Compliance Document, as delineated in AC 120-AAWG, be published by December 20, 2008, and the new and updated model specific data to support operator compliance be published by December 18, 2009. In addition, the AAWG recommends that the AAWG oversee the development of this data as delineated in Appendix E.

Appendix A: Copy of FAA Tasking Notice

Federal Register / Vol. 69, No. 93 / Thursday, May 13, 2004 / Notices

Pages 26641 through 26644

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

Aviation Rulemaking Advisory Committee; Transport Airplane and Engine Issues—New Task

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice of new task assignment for the Aviation Rulemaking Advisory Committee (ARAC).

SUMMARY: The FAA assigned the Aviation Rulemaking Advisory Committee a new task to develop guidance that will support industry compliance with the Aging Airplane Safety Final Rule requirements that relate to supplemental structural inspections. This new tasking will also address certain aspects of recommendations made during a previous ARAC tasking related to widespread fatigue damage. This notice is to inform the public of this ARAC activity.

FOR FURTHER INFORMATION CONTACT: Mike Kaszycki, Federal Aviation Administration, Transport Standards Staff, 1601 Lind Avenue, SW., Renton, Washington 98055–4056, *mike.kaszycki@faa.gov.*

SUPPLEMENTARY INFORMATION:

Background

The FAA established the Aviation Rulemaking Advisory Committee to provide advice and recommendations to the FAA Administrator on the FAA's rulemaking activities with respect to aviation-related issues. This includes obtaining advice and recommendations on the FAA's commitments to harmonize Title 14 of the Code of Federal Regulations (14 CFR) with its partners in Europe and Canada.

Airplane Applicability of Tasking

This new tasking shall apply to transport category airplanes with a type certificated passenger seating capacity of 30 or greater, or a maximum payload capacity of 7,500 pounds or greater, operated under part 121 or under part 129 (U.S. registered airplanes).

Statement of Tasking

There are four major tasks to be completed under this tasking:

Task 1.—Repairs to Baseline Primary Structure and Repairs to Alterations and Modifications

Draft an Advisory Circular (AC) that contains guidance to support the following two paths of compliance with §§ 121.370a and 129.16 of the Aging Airplane Safety Interim Final Rule (AASIFR):

1. *Damage-tolerance-based inspection program developed by part 121 and 129 certificate holders:* Develop guidelines and procedures that will enable part 121 and 129 certificate holders to develop a damage-tolerance-based inspection program that addresses repairs made to aircraft structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure.

2. *Model specific damage-tolerance-based inspection program:* Develop Guidance that can be used by Type Certificate (TC) holders, Supplemental Type Certificate (STC) holders, and Structural Task Groups to support the development of a model specific damage-tolerance-based inspection program. The model specific damage-tolerance-based inspection program will address repairs made to aircraft structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure. The developed model specific inspection program will support part 121 and 129 certificate holders' compliance with the AASIFR.

A written report will also be submitted that includes an action plan for the implementation of the recommendations of task 1 that will be addressed in task 4 below. The report is to be submitted to the Aviation Rulemaking Advisory Committee (ARAC), Transport Airplane and Engine Issues Group, for approval. The ARAC, Transport Airplane and Engine Issues Group, will determine as appropriate the means by which the action plan will be implemented. The proposed actions and implementation process approved by the ARAC, Transport Airplane and Engine Issues Group, will be subject to FAA concurrence.

In the process of drafting the AC, the ARAC should assess the effectiveness of AC 91–56B to provide guidance to TC and STC holders for developing damage-tolerance-based inspections and procedures for repairs made to aircraft structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure. The ARAC should do the following:

• Assess the effectiveness of AC 91– 56B to support Industry compliance with the AASIFR with respect to repairs.

• Document any improvements to the AC that would provide better direction with respect to the guidance for TC and STC holders in their development of damage-tolerance-based inspections and procedures for repairs.

The ARAC is requested to validate that the guidance material in the new AC will result in programs that provide a high degree of autonomy for part 121 and 129 certificate holders while supporting compliance with the AASIFR. In order to determine a rational approach for addressing repairs to aircraft structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure, and are not currently covered by a mandated program, the AC should provide guidance to the part 121 and 129 certificate holders and to the type certificate holder to address the seven issues listed below.

1. The significance of the airplane certification amendment level in providing direction for the development of damage tolerance inspections and methods for repairs.

2. The degree to which Supplemental Structural Inspection Documents/ Programs (SSID/P) or equivalent documents/programs provide direction to repair the structure using damage-tolerance-rated repairs. The assessment should apply to SSID/Ps or equivalent documents/programs developed for 14 CFR part 25 pre-amendment 25–45 transport airplane models having a maximum gross takeoff weight of 75,000 lbs or greater. The following should be identified:

• Areas of aircraft structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure, which are not covered by SSID/ Ps or equivalent documents/programs

• Significant assumptions applied in developing SSID/Ps or equivalent documents/programs

• Any significant issues in the implementation of the requirements of SSID/Ps or equivalent documents/ programs

• Data from SSID/Ps or equivalent documents/programs that would be useful in supporting this new tasking

3. The degree to which an applicable airplane model's Airworthiness Limitations Section (ALS) provides direction to repair the structure using damage-tolerance-rated repairs. This assessment should apply to damage-tolerance-based inspection programs/ data developed for 14 CFR part 25 amendment 25–45 or later transport airplane models having a maximum gross takeoff weight of 75,000 lbs or greater. The following should be identified:

• Areas of aircraft structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure, which are not covered by a damage-tolerance-based inspection program/data

• Any significant issues in the implementation of the requirements of the damage-tolerance-based inspection programs/data

• Data from the damage-tolerance-based inspection programs that would be useful in supporting this new tasking

4. The degree to which existing Repair Assessment Guideline documents developed for §§ 121.370 and 129.32 provide damage-tolerance-based inspections for repairs made to aircraft structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure. The assessment should identify the following:

• Areas of the aircraft structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure, which are not covered by these documents

• Data from these documents that would be useful in supporting this new tasking

5. Identify the issues/difficulties industry has encountered with establishing damage-tolerance-based inspections and procedures for repairs as required by various FAA approaches in issuing SSIP airworthiness directives (*e.g.*, 727/737 AD 98–11–03 R1,

AD 98– 11–04 R1 verses other SSIP AD approaches like the 747). The assessment should identify the following:

• Comparison of approaches with pros and cons for each approach

• Data from these documents that would be useful in supporting this new tasking

6. Assess the extent to which Structural Repair Manuals (SRM) provide damage-tolerance-based inspections for repairs made to aircraft structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure.

7. Assess the need to include damage-tolerance-based inspections and procedures in TC and STC Holder issued Service Bulletins (SB) that provide repair instructions for aircraft structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure.

Task 2.—Alterations and Modifications to Baseline Primary Structure, Including STCs and Amended Type Certificates (ATCs)

Prepare a written report assessing how an operator would include damage tolerance-based inspections and procedures for alterations and modifications made to aircraft structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure. This assessment would include, but is not limited to, alterations and modifications performed under an STC, ATC, FAA field approval (*e.g.*, FAA form 337) and/or FAA approved TC holder design data. The report should include a recommendation on the best means to develop damage-tolerance-based inspections and procedures for these alterations and modifications and the applicability of AC 91–56B. The ARAC should assess the effectiveness of AC 91–56B to provide guidance to STC holders for developing damage-tolerance-based inspections and procedures for alterations and modifications. The ARAC should do the following:

• Assess the effectiveness of AC 91– 56B to support Industry compliance with the AASIFR with respect to alterations and modifications.

• Document any improvements to the AC that would provide better direction with respect to the guidance for STC holders in their development of damage-tolerance-based inspections and procedures for alterations and modifications.

The written report will include a proposed action plan to address and/or accomplish these recommendations, including actions that should be addressed in task 4 below. The report should also provide a recommendation on the means of compliance provided by the AC developed in Task 1 in regards to repairs installed on STC or ATC approved alterations and modifications. The report is to be submitted to the ARAC, Transport Airplane and Engine Issues Group, for approval. The ARAC, Transport Airplane and Engine Issues group, will determine as appropriate the means by which the action plan will be implemented. The proposed actions and implementation process approved by the ARAC, Transport Airplane and Engine Issues Group, will be subject to FAA concurrence (FAA concurrence is necessary to ensure actions will support industry compliance with the AASIFR).

Task 3.—Widespread Fatigue Damage (WFD) of Repairs, Alterations, and Modifications

Provide a written report providing recommendations on how best to enable part 121 and 129 certificate holders of airplanes with a maximum gross take-off weight of greater than 75,000 pounds to assess the WFD characteristics of structural repairs, alterations, and modifications as recommended in a previous ARAC tasking. The written report will include a proposed action plan to address and/or accomplish these recommendations including actions that should be addressed in task 4 below. The report is to be submitted to the ARAC, Transport Airplane and Engine Issues Group, for approval. The ARAC, Transport Airplane and Engine Issues Group, will determine as appropriate the means by which the action plan will be implemented. The proposed actions and implementation process approved by the ARAC, Transport Airplane and Engine Issues Group, will be subject to FAA concurrence.

Task 4.—Model Specific Programs

Oversee the Structural Task Group (STG) activities that will be coordinated for each applicable airplane model by the respective type certificate holders' and part 121 and 129 certificate holders. These STG activities will involve the development of model specific approaches for compliance with §§ 121.370a and 129.16 under the guidance material supplied in Task 1. As part of this tasking, the AAWG will identify those airplane models that do not have an STG, and will assess the need to form one (based on industry benefit). For those airplane models that will need to form an STG, the AAWG will initiate the coordination required to form the STG with the respective type certificate holder and/or part 121 and 129 certificate holders.

In addition, the AAWG will support the implementation of the action plan to address recommendations made in tasks 2 and 3 as determined necessary by the ARAC, Transport Airplane and Engine Issues Group, and concurred with by the FAA.

Schedule

The tasking will be performed in two phases. In Phase 1, the ARAC will provide to the FAA the results of Tasks 1 through 3. Phase 1 should be accomplished by December 16, 2005. In Phase 2, the Structures Task Groups, under the direction of the ARAC, should produce the model specific guidance material, Task 4, using the guidelines and procedures of the AC produced in Phase 1. The ARAC will be responsible for coordinating and overseeing the STG's application of the AC. Phase 2 documents should be completed by December 18, 2009.

ARAC Acceptance of Task

ARAC accepted the task and assigned the task to the Airworthiness Assurance Working Group, Transport Airplane and Engine Issues. The Structural Task Groups (STG) composed of type certificate and part 121 and 129 certificate holders familiar with the specific model aircraft will support the working group. The working group will serve as staff to ARAC and assist in the analysis of the assigned task. ARAC must review and approve the working group's recommendations. If ARAC accepts the working group's recommendations, it will forward them to the FAA.

Working Group Activity

The Airworthiness Assurance Working Group must comply with the procedures adopted by ARAC. As part of the procedures, the working group must:

1. Recommend a work plan for completion of the task, including the rationale supporting such a plan for consideration at the next meeting of the ARAC on transport airplane and engine issues held following publication of this notice.

2. Give a detailed conceptual presentation of the proposed recommendations prior to proceeding with the work stated in item 3 below.

3. Draft the appropriate documents and required analyses and/or any other related materials or documents.

4. Provide a status report at each meeting of the ARAC held to consider transport airplane and engine issues.

Participation in the Working Group

The Airworthiness Assurance Working Group will be composed of technical experts having an interest in the assigned task. A working group member need not be a representative or a member of the full committee. If you have expertise in the subject matter and wish to become a member of the working group you should write to the person listed under the caption **FOR FURTHER INFORMATION CONTACT** expressing that desire, describing your interest in the task, and stating the expertise you would bring to the working group. We must receive your request to participate no later than May 28, 2004. The assistant chair, the assistant executive director, and the working group chair will review your request and will advise you whether your request is approved. If you are chosen for membership on the working group, you must represent your aviation community segment and actively participate in the working group (*e.g.*, attend all meetings, provide written comments when requested to do so, *etc.*). You must also devote the resources necessary to support the working group in meeting any assigned deadlines. You must keep your management chain and those you may represent advised of working group activities and decisions to ensure that the proposed technical solutions don't conflict with your sponsoring organization's position when the subject being negotiated is presented to ARAC for approval.

Once the working group has begun deliberations, members will be added or substituted only with the approval of the assistant chair, the assistant executive director, and the working group chair.

The Secretary of Transportation determined that the formation and use of the ARAC is necessary and in the public interest in connection with the performance of duties imposed on the FAA by law.

Meetings of the ARAC will be open to the public. Meetings of the Airworthiness Assurance Working Group will not be open to the public, except to the extent that individuals with an interest and expertise are selected to participate. The FAA will make no public announcement of working group meetings.

Issued in Washington, DC, on May 4, 2004.

Anthony F. Fazio,

Executive Director, Aviation Rulemaking Advisory Committee.

[FR Doc. 04–10816 Filed 5–12–04; 8:45 am]

BILLING CODE 4910–13–P

Appendix B: Draft AC 120-AAWG

ADVISORY CIRCULAR

DAMAGE TOLERANCE INSPECTIONS FOR REPAIRS

TABLE OF CONTENTS

CHAPTER 1. PURPOSE OF THIS ADVISORY CIRCULAR

100. PURPOSE.

a. This Advisory Circular (AC) provides guidance material for design approval holders (DAH) and operators in developing and incorporating Damage Tolerance Inspections and Procedures (DTIP). The AC will support compliance with 14 CFR Parts 121.370a and 129.16, the Aging Airplane Safety Final Rule (AASFR) with respect to repairs. This AC is applicable to repairs to structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure. This structure is referred to in this AC as fatigue critical structure.

b. This includes repairs made to the as delivered airplane structural configuration as well as repairs to alterations and modifications. For operators to comply they will need to demonstrate that new and existing repairs will have an evaluation and have DTIP or other procedures implemented if needed. This AC provides guidance for addressing both new and existing repairs.

101. APPLICABILITY.

This AC is applicable to Type Certificate Holders, Supplemental Type Certificate Holders and operators of transport category airplanes with a type certificated passenger seating capacity of 30 or greater, or a maximum payload capacity of 7,500 pounds or greater. The applicability is limited to airplanes operated under Parts 121 or 129 (US Registered Airplanes).

102. DAMAGE TOLERANCE INSPECTIONS AND PROCEDURES, DAMAGE TOLERANCE EVALUATION PROCESSES (DTE PROCESSES) AND DAMAGE TOLERANCE DATA (DT DATA).

a. The term Damage Tolerance Inspections and Procedure used in the AASFR is synonymous with the term Damage Tolerance Data (DT data) used in this AC and described below. These Damage Tolerance Inspections for repairs supplement existing regulator approved maintenance programs including those contained in the instructions for continued airworthiness, scheduled maintenance programs, SSID and ALI programs, Service Bulletins, and Repair Assessment Programs.

b. Amendment 45 to 14 CFR Part 25 introduced the use of damage tolerance principles. This approach requires an evaluation of the structure to determine its crack growth and residual strength characteristics. The evaluation supplies the information necessary to determine a maintenance plan for continued airworthiness. For this AC, the term DTE processes refers to an approved process, that includes, analysis and/or tests and service data, that leads to a determination of a continuing airworthiness maintenance plan, including inspections (i. e. DTI), or other procedures for a repair or replacement of fatigue critical structure. Consistent with the guidance provided by this AC, a DTE process could entail anything from a rigorous analysis methodology for use by a structures analyst to generic guidelines for operator use. This process will enable a survey and assessment of existing repairs to be made. In this AC, DTE processes plus DTI is referred to collectively as DT data.

c. DTE processes typically result in four items that comprise the DTI. Those are as follows:

- Where to inspect.
- When to start inspecting.
- How to inspect.
- How often to repeat the inspection.

d. For some airplane models, the requirements of the AASFR are beyond the scope of the original certification level. For these airplanes, development of DT data and incorporation of that data into the existing maintenance program is required. For other models, there are DT data included in various documents, for example Supplemental Structural Inspection Document/Program (SSID/P), Repair Assessment Guidelines (RAGs), Airworthiness Limitation Sections (ALSs), Structural Repair Manuals (SRMs), and Airworthiness Directives (ADs). Operators may use these DT data in part or in whole to support compliance with the requirements of the AASFR for repairs.

e. Sometimes, the results of the DTE process may indicate that inspections are either impractical or unreliable. In such cases, the continued airworthiness of the airplane is assured by establishing a replacement time for the repair.

103. OVERVIEW OF DT DATA DEVELOPMENT AND INCORPORATION.

a. Developing DT data involves accomplishing tasks typically performed by a DAH assisted by interested operators. The product is an FAA-ACO approved model specific compliance document that contains the output from the tasks. Incorporation of the DT data into a maintenance program involves accomplishing tasks that are typically performed by an operator. The product is an FAA-PMI approved airplane specific Operator Implementation Plan.

b. It is expected that DAHs, operators and regulators would develop model specific compliance documents. Industry Task Groups such as the Airworthiness Assurance Working Group (AAWG) would perform this task.

c. The following is a summary of the tasks necessary to develop DT data for repairs and incorporate it into an operator's maintenance program:

(1) DAH Tasks. The following is an overview of the DAH tasks that are further developed in Chapter 2.

(a) Identify the affected airplane model, models, or airplane serial numbers the DT data will be applicable to.

(b) Identify the fatigue critical structure.

(c) Identify the certification level.

(d) Review of existing DT data.

(e) Develop additional DT data.

(f) Establish Implementation Schedule.

(g) Prepare Compliance Document. This is a model or airplane specific document that contains the information from Paragraphs (a) through (f) above. The operator will use this document to develop an implementation plan for complying with the AASFR. In order to support operator compliance to the AASFR, the DAH should submit the Compliance Document to the FAA-ACO for approval and should make it available by December 18, 2009.

(2) Operator Tasks. The following is an overview of the operator tasks that are further developed in Chapter 3.

(a) Review The Applicable Compliance Documents.

(b) Development Of An Operators Implementation Plan. This is specific to the identified airplane or group of airplanes to which the Plan applies and contains information from Paragraph **(1)(g)** above. The Operator will submit the Implementation Plan for approval by the FAA-PMI.

(c) Incorporate The DT Data For New And Existing Repairs into Operators Maintenance Program.

104 thru 199 RESERVED.

CHAPTER 2. DESIGN APPROVAL HOLDERS TASKS

200. GENERAL INFORMATION ABOUT THIS CHAPTER.

This chapter gives guidance to design approval holders for developing data to support operator compliance with the rule. This includes the development of damage tolerance procedures, DTE processes, and DT data.

201. DEVELOPMENT OF COMPLIANCE DOCUMENTS.

a. Persons supporting the operation of airplanes under 14 CFR 121 and 129 should use the following guidance material to develop data necessary to facilitate operator compliance. Airplanes certified to Amendment 54, or later, may not need additional DT data to be developed. While data may not need to be developed, an operator will still need to demonstrate to his PMI how his existing maintenance program meets the intent of the AASFR relative to new and existing repairs.

b. To facilitate compliance with the AASFR with respect to repairs, compliance documentation should be created that will encompass all fatigue critical structure, including repairs to repairs, alterations, and modifications (RAM) as necessary. The compliance document will be applicable to a specific airplane model or airplane serial number. The documentation should provide the data necessary for developing an Operator Implementation Plan with respect to a given airplane. The Compliance Document should also include implementation schedule information as well as specific guidance on which repairs will require evaluation. The process for evaluation of repairs contained in this AC considers both existing and future repairs. Existing repairs will be brought into the program using the implementation plan and airplane surveys after December 20, 2010 (See Appendix 5). New repairs, installed after December 20, 2010 will be required to have DT data provided within the guidelines contained in Appendix 4.

c. Where specific DT data needs to be developed to support compliance to the AASFR, it is recommended that the model-specific Compliance Document be produced as a joint effort between the DAH, operators, and Regulatory Authorities. In previous aging aircraft programs, the AAWG formed Structures Task Groups (STGs) to develop the model specific programs. Where necessary an STG for this activity should be formed and tasked to develop the model-specific Compliance Document.

d. Figure 1 shows the process that may be used to produce a Compliance Document that supports compliance with the AASFR for repairs to fatigue critical structure:

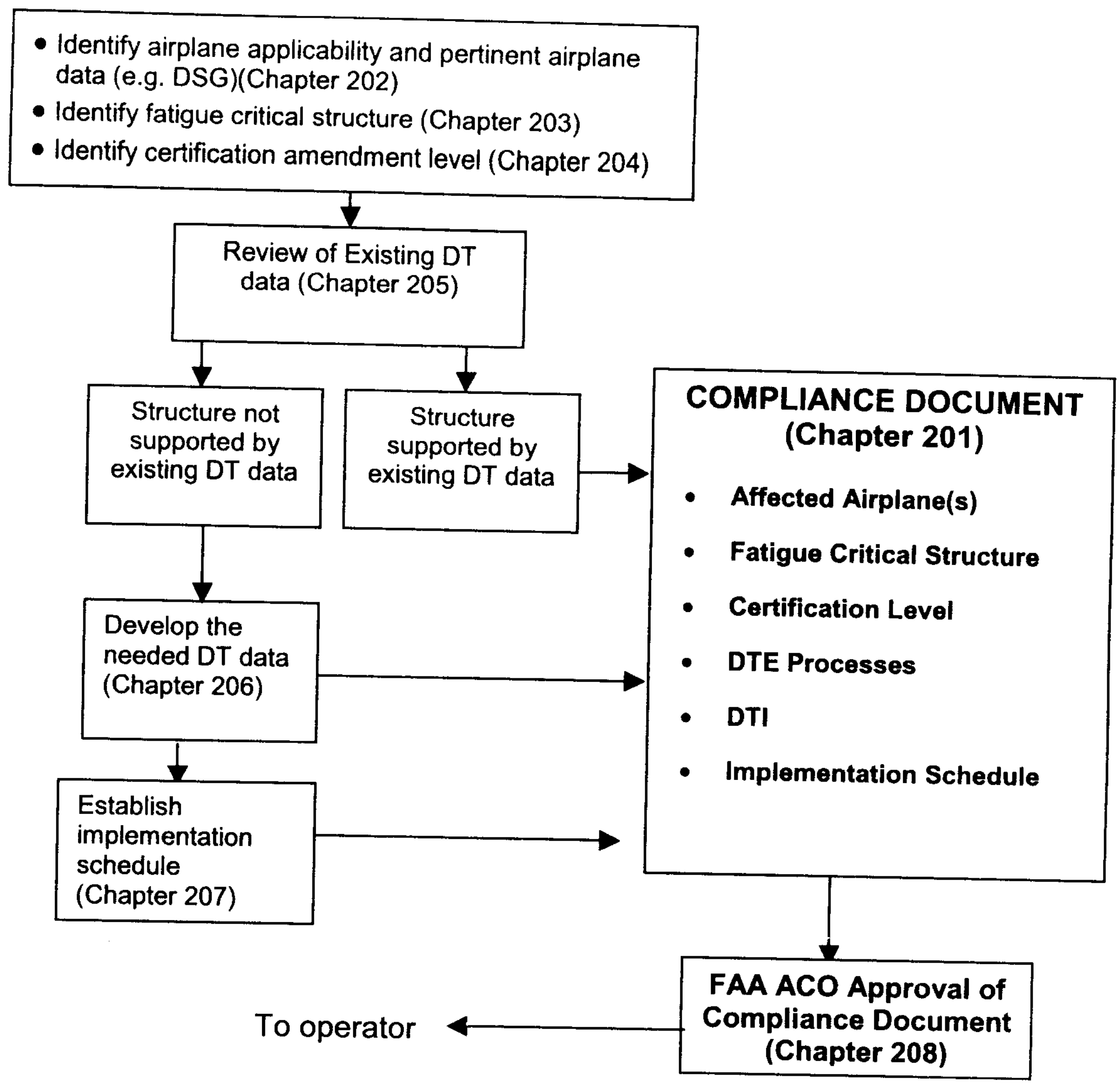


Figure 1. Development of a Compliance Document.

202. IDENTIFICATION OF AFFECTED AIRPLANES.

The airplane model and model variations or serial numbers, including gross weights, applicable to the Compliance Document should be identified. For each model of airplane, the DAH will identify the DT data to support compliance with the AASFR. Some models may not require additional data

203. IDENTIFICATION OF FATIGUE CRITICAL STRUCTURE.

a. The DAH will identify and make available in the Compliance Document a description of structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure for each applicable airplane model. This structure is referred to as "fatigue critical structure". Guidance for identifying this structure can be found in AC 25.571-1C. When fatigue critical structure is repaired the repaired fatigue critical structure requires DTE to comply with the AASFR. This includes repairs to alterations and modifications of fatigue critical structure. Structure not defined as fatigue critical structure would not require DTE when repaired.

b. When identifying fatigue critical structure, it should be considered that some SSID programs or ALS contained in the Instructions for Continued Airworthiness might only include supplemental inspections of critical elements of the fatigue critical structure as determined by the Damage Tolerance Analysis. Other areas of structure may require supplemental inspections if repaired. In defining the fatigue critical structure it is not sufficient to consider only that structure contained in the SSID program or ALS.

c. STC Holders should obtain the description of fatigue critical baseline structure from the Type Certificate Holder. If the alteration affects this fatigue critical structure, any repairs to the alteration must have a Damage Tolerance Assessment performed. This damage tolerance assessment must address any fatigue critical structure of the alteration and of the baseline structure that is affected by the repair. This information should be incorporated into a compliance document that is unique to the alteration.

204. CERTIFICATION AMENDMENT LEVEL.

In order to understand what data is required for compliance with the AASFR for repairs, the DAH should identify the amendment level of the original certification relative to 14 CFR Part 25.571. The amendment level is useful in identifying what DT data may be applicable for compliance to the AASFR and what standard should be used for development of data for AASFR compliance. The two airplane groups that are relevant to the AASFR are:

a. Group A - Airplanes certified before 14 CFR 25.571 Amendment 25-45, damage tolerance requirements. These airplanes were not evaluated for damage tolerance as part of the original type certification. Therefore, the requirements of the AASFR are beyond the scope of the original certification amendment level. Repairs to fatigue critical structure will need development of DT data unless previously accomplished.

b. Group B - Airplanes certified to 14 CFR 25.571 Amendment 25-45 or beyond, Repairs to these aircraft will need to meet their certification level. Although these airplanes were evaluated for damage tolerance, they may not have repair data that includes DT data. In this situation, the DAH and operators may need to identify and perform a DTE of these repairs and develop DTI or other procedures.

205. REVIEW OF EXISTING DT DATA.

a. Introduction

(1) Based on the certification amendment level and existing rules, the DAH developed documents that may provide DT data to support compliance with the AASFR for repairs. These documents may include:

- **(a)** Repair Assessment Guidelines (RAG)
- **(b)** Structural Repair Manual
- **(c)** Individual Repairs
  - **i** To areas covered by ALS, SSIP and RAP
  - **ii** Other individual repairs
- **(d)** Service Bulletins that provide
  - **i** Inspections for RAMs
  - **ii** Significant modification or
  - **iii** Repair service bulletins
- **(e)** ADs that mandate
  - **i** Modifications or repairs
  - **ii** Inspections to STCs

(2) Review each of the items above to determine the applicability of the data for compliance to the AASFR.

b. Identifying Existing DT Data.

(1) Identify repairs that have existing DT data that will support compliance with the AASFR. This material will form a portion of the data for the Compliance Document.

(2) The following documents may contain data that may be applicable in showing compliance to the AASFR.

(a) RAGs. The programs developed for complying with §121.370 and 129.32 resulted in model specific repair assessment guidelines (RAGs). These documents provide support in complying with the AASFR for repairs to the fuselage pressure boundary. Additionally, under certain circumstances, the RAG documents developed may be applicable to repairs to STC's that are modifications to the fuselage pressure boundary.

(b) SBs, ADs. Review Service Bulletins and ADs that provide instructions to inspect, or repair fatigue critical structure. Determine if it supports compliance with the AASFR. The DAH should propose a process for review of these bulletins.

(c) SRMs. The Structural Repair Manual may contain some of the information required for compliance to the AASFR and other existing programs, such as the SSIP and RAP. Review SRMs to identify all repairs to fatigue critical structure and if those repairs have had DT data established.

206. DEVELOPMENT OF ADDITIONAL DT DATA TO SUPPORT COMPLIANCE.

a. Introduction.

(1) When developing DT data, use of the damage tolerance requirements depends on the certification level of the affected airplane. For Group A airplanes use the requirements of 14 CFR 25.571 at Amendment 45 as a minimum standard. For Group B airplanes use the requirements that correspond to their original certification level as a minimum standard.

(2) Consider the following repairs and develop DT data according to the minimum standard determined in (1) above:

(a) SRM Repairs.
(b) SB Repairs.
(c) AD Mandated Repairs.
(d) DAH reviewed and approved repairs that have general interest (multiple airplane approvals).
(e) Other repairs, including third-party approved repairs and repairs that deviate from published repairs that otherwise qualify as damage tolerant.

(3) For future repairs, damage tolerance evaluation on an individual repair basis is acceptable. However, it may be more efficient to use published repair instructions such as SRMs or RAGs that contain already approved DT data. For published repair data to be acceptable, it should contain a statement of DTE accomplishment.

(4) For existing repairs that are identified during an individual airplane review, there are at least two possible approaches to evaluate a repair. The first would involve a damage tolerance analysis on individual repairs as those repairs are identified. This will be necessary for unique and complex non-routine repairs. Another approach would be to develop guidelines to assess repairs that are not addressed by existing RAGs developed for compliance to 14 CFR 121.370. The development of these additional guidelines is complex and therefore requires the support of the DAH.

b. Performing DTEs and developing DTI on a case-by-case basis. If performing DTEs and developing DTI on a case-by-case basis, use the guidance included in AC 25.571 consistent with the certification amendment level identified in Chapter 2, paragraph 204 of this AC.

c. Development of additional repair assessment guidance. The update of the SRM, SBs, together with the existing RAG documents form the core of the information supplied to the operator for compliance to the AASFR. A means will be developed and documented in the compliance document to assist the operator in evaluating repairs using the updated published standards and to determine if additional DAH support is necessary. This support may be in the form of individual repair DTA data requests or new repair evaluation guidelines (e.g. may cover fatigue critical structure of the wing, fuselage, empennage, etc.). The means developed should provide operators with a high degree of confidence that they can comply with the requirements of the AASFR.

In the development of new evaluation guidelines, the percentage of existing repairs that could be addressed by the new repair guidance material should weighed against the resources and time required to develop and have the guidance approved. General guidance on development of this material can be found in AC 120-73 even though this guidance is for the Fuselage Pressure Boundary.

Damage tolerance inspections and procedures means establishing the following:

(1) A threshold for when to commence inspections of the structure.
(2) A repetitive interval for repeat inspections
(3) A means of inspection.
(4) Occasionally, a life limit for replacing structure.

For repairs, the following repair category terminology that is contained in AC 120-73 is used herein to describe the maintenance requirements.

For Category A repairs, normal maintenance procedures (inspection threshold and /or BZI) are sufficient to provide the required damage tolerance coverage.

For Category B repairs, items 1, 2, and 3 above are normally provided as part of the damage tolerance package.

For Category C repairs, all four items are provided as necessary.

d. SRMs. Based on the review performed in Chapter 205, determine if the SRM needs revision to support compliance with the AASFR. Base this determination on the following:

(1) Whether the existing SRM contains an adequate description of damage tolerance data for the specific model. This includes defined repair categories.

(2) Whether normal maintenance procedures (for example the inspection threshold and/or baseline zonal inspection program) covers Category A repairs.

(3) Whether the SRM contains an identification of fatigue critical structure for the model specific airplane that, if repaired, will need a damage tolerance assessment.

(4) Whether SRM Chapter 51 standard repairs have a DT evaluation.

(5) Whether all SRM specific repairs for fatigue critical structure have DT Data.

(6) Whether there is specific guidance on the size of repairs that would qualify as Category A repairs.

(7) Whether there is any guidance on proximity of repairs and the effect of this condition on damage tolerance characteristics.

(8) The need to address superseded repairs and how DT data for future superseded repairs will continue to be made available.

e. Service Bulletins. Based on the review performed in Chapter 205 determine if the SBs need DT data to support compliance with the AASFR. Compliance Document needs to identify the status of the DT data for those service bulletins.

207. IMPLEMENTATION SCHEDULE.

The implementation schedule described in this Paragraph represents an acceptable time line to establish DT data and continued airworthiness maintenance plans for both existing and new repairs. Justify any deviation to the time line and present it to the FAA oversight office for approval. Include the information contained in this chapter in the Compliance Document to support the operator in developing an implementation plan for his particular fleet of airplanes. This Implementation Schedule will support compliance to 14 CFR 121.370a (1) with respect to the requirement to address the adverse effects repairs have on fatigue cracking and the inspection of fatigue critical structure. In principle this implementation schedule is similar to the implementation schedule adopted for compliance to 14 CFR 121.370.

a. Existing repairs that already have DT data developed and in place in the maintenance program. These repairs require no further action.

b. Existing repairs that either require developing DT data or have not had ICA embodied in the maintenance program. Identify and evaluate all existing repairs to fatigue critical structure. For the purposes of compliance to the AASFR, only existing repairs that reinforce (e.g. restore strength) the fatigue critical structure need to be considered; this typically excludes maintenance actions such as blend-outs, plug rivets, trim-outs, etc. For those existing repairs that do not have DT data or other procedures implemented, establish that data according to an FAA approved plan. Assessing existing repairs consists of:

- Airplane Repair Survey.
- Identification and Disposition of repairs requiring immediate action.
- DTI Development.

Appendix 5 defines these three steps. The timing allowance for each of these steps for any given airplane depends on the age of the airplane on December 18, 2009. The following program will support the DAH development of an Implementation Schedule for the Compliance Document. This implementation schedule would be incorporated as part of the Operator's Implementation Plan developed in Chapter 3 of this AC.

(1) Implementation Schedule for Survey and Disposition.

(a) Airplanes less than 75% DSG on December 18, 2009. Operators would complete a survey at the first D-check after 75% DSG, not to exceed DSG, completing steps 1 and 2 of the DTI assessment process (see Appendix 5). After accomplishing step 1, complete step 3 of Appendix 5 within 12 months.

(b) Airplanes between 75% DSG and DSG on December 18, 2009. Operators would complete a survey of these airplanes completing steps 1 and 2 of the DTI assessment process (see Appendix 5) at or before the next major check (equivalent to a D-check) after December 20, 2010, not to exceed DSG or 6 years whichever is greater. After accomplishing step 1, complete step 3 of Appendix 5 within 12 months.

(c) Airplanes greater than the DSG on December 18, 2009. Operators would complete a survey of these airplanes completing steps 1 and 2 of the DTI assessment process (see Appendix 5) at or before the time limit equivalent to a D-check after December 20, 2010, not to exceed 6 years. Operators should not defer the implementation of the program until the end of the D-check time period. For example, if an operator had 30 airplanes over DSG on December 18, 2009 and was operating on a six year D-check equivalent, the operator would inspect approximately 5 equivalent airplanes each year until all of the airplanes were inducted into the program. Within 12 months after accomplishing Step 1, complete step 3 of Appendix 5.

NOTE: The DAH will identify the established DSG for a particular airplane type that is representative of the airplane considering the probable variation of the number of flight hours per cycle that could exist in the fleet.

(2) Implementation of DTI.

(a) Once the DTI is known, accomplish the first inspection of the repair according to the schedule of the DTI as follows:

i Inspect the repair before the inspection threshold or within a time limit equivalent to a C-check from accomplishment of the assessment, whichever occurs later.

ii If the age of the repair is unknown, use the aircraft age in cycles or hours.

(b) Implement repeat inspection intervals per the instructions provided.

d. New Repairs. Unless already required by the airplane certification level or other FAA approved program, all new repairs to fatigue critical structure installed beginning December 21, 2010, and thereafter must have DTE performed. Implement DTI according to the process described in Appendix 4, "Approval Process for New Repairs". This includes blendouts, trim-outs, etc. that are beyond published DAH limits.

e. Repairs to Removable Structural Components. Fatigue critical structure may include structure on removable structural parts or assemblies that can be exchanged from one aircraft to another such as door assemblies, flight control surfaces, etc. In principle, the DT data development and implementation process also applies to repairs to fatigue critical structure on components. During their life history, however, these parts may not have had their flight times recorded on an individual component level because of removal and reinstallation on different airplanes multiple times. These actions may make it impossible to determine the age or total hours/cycles. In these situations, guidance for handling DT data development and implementation for existing and new repairs is given in Appendix 6.

208. FAA ACO APPROVAL OF COMPLIANCE DOCUMENT.

The FAA oversight office for the affected airplane or STC will approve the Compliance Document and any revision to an FAA-approved Compliance Document.

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CHAPTER 3. OPERATOR TASKS

300. GENERAL INFORMATION ABOUT CHAPTER 3.

This Chapter will guide operators on the procedures to obtain damage tolerance inspections and procedures. This Chapter will additionally guide operators on how to revise their maintenance programs as required by 14 CFR 121.370a and 129.16.

301. DEVELOPMENT OF AN OPERATORS IMPLEMENTATION PLAN

The AASFR requires affected air carrier certificate holders to incorporate FAA-approved DTE Processes and DTI into their maintenance programs by December 20, 2010 for repairs to fatigue critical structure. This includes both existing and new repairs and repairs to repairs, alterations and modifications of fatigue critical structure. The means of incorporating DT data into a certificate holder's FAA-approved maintenance program is subject to approval by the certificate holder's Principal Maintenance Inspector (PMI) or other airworthiness inspector. The Compliance Document developed using Chapter 2 of this AC provides the basic guidance, including identification of the fatigue critical structure, DT data and implementation schedule information.

Incorporate the information that includes the Compliance Document processes, data, and requirements into the operator's existing maintenance program in a way that best fits their existing maintenance programs. The PMI or airworthiness inspector will then approve the Operator's Implementation Plan.

302. REVIEW OF APPLICABLE COMPLIANCE DOCUMENTS.

a. For each affected airplane in an operator's fleet, the operator should review the FAA ACO-approved Compliance Documents (discussed in Chapter 2, above) that are applicable. The Compliance Document will identify all fatigue critical structure, the DT data for the fatigue critical structure, and implementation schedule information for incorporating DT data into the operator's maintenance program.

b. In addition, the operator should review any additional FAA ACO approved Compliance Documents associated with a given model aircraft, for repairs to RAMs and third-party approved repairs. These may be applicable to the entire model fleet or to individual aircraft within a given fleet type. These Compliance Documents will also identify all fatigue critical structure for that fleet type, the DT data for the fatigue critical structure, and implementation schedule information for incorporating DT data into the operator's maintenance program.

c. Figure 2 below shows how an operator can develop an Operator Implementation Plan for airplanes in his fleet using the Compliance Document. While the

Implementation Plan is airplane specific, it may incorporate processes and procedures that are applicable to other airplanes operated by a certificate holder. This includes administrative procedures for applying elements common to each Implementation Plan. Consider the guidance in the following flow-chart when developing an Operator Implementation Plan.

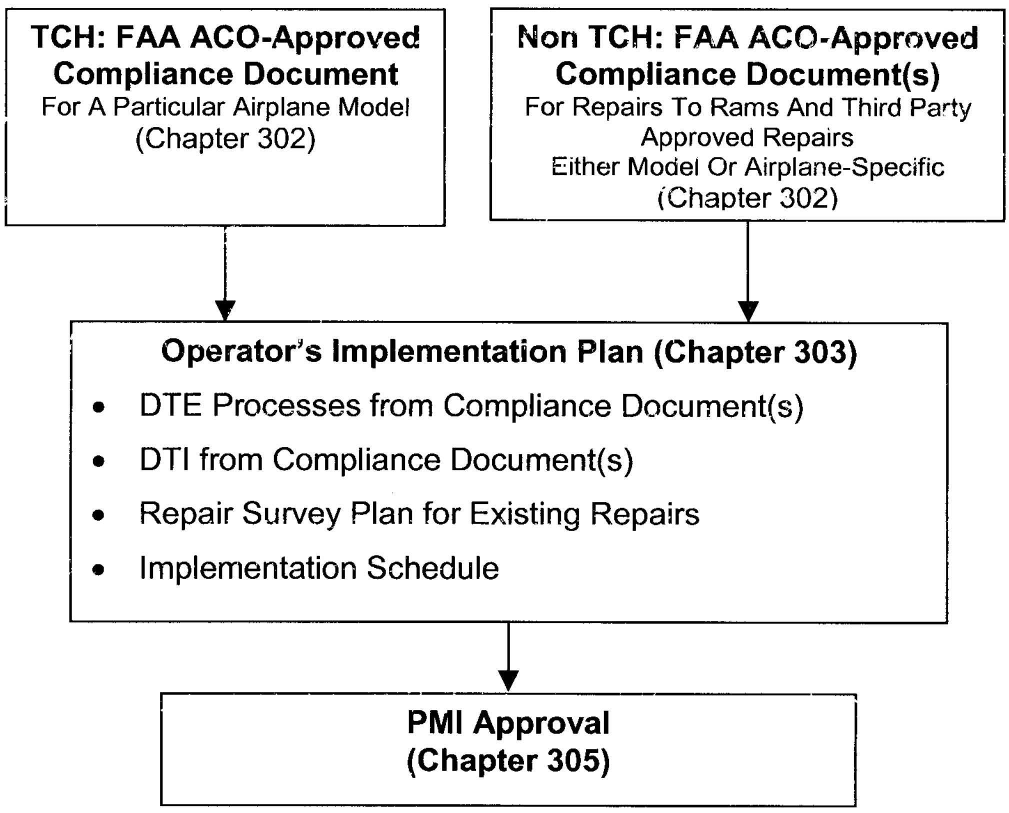

Figure 2. Operator's Implementation Plan Approval Process.

303. INCORPORATION OF DT DATA FOR NEW AND EXISTING REPAIRS.

After the reviews of the applicable Compliance Document are complete, the operator should include the following into an Operator Implementation Plan:

a. A process to ensure that all new repairs to fatigue critical structure will be evaluated for damage tolerance and have DTI or other procedures implemented.

b. A process to ensure that all existing repairs to fatigue critical structure are evaluated for damage tolerance and have DTI or other procedures implemented. This process would include:

(1) A review of operator processes to determine if DT data for fatigue critical structure is incorporated throughout the life of the airplane. If so, no further action is required for existing repairs.

(2) Incorporation of processes to survey existing repairs to fatigue critical structure and determine DTI for those repairs. Derive these processes from the Compliance Document applicable to those airplanes. Incorporate them into the operator's maintenance program within the time frame given in the Compliance Document.

c. An implementation schedule following guidance provided in the Compliance Documents.

d. Repair Survey Plan. Utilizing the survey parameters from chapter 2 above the operator would devise a plan to survey its airplanes for repairs that may need DT data developed. This survey plan may be divided into three groups of airplanes, those that are below 75% DSG, those that are between 75% DSG and DSG and those above DSG on December 18, 2009. (Note: In the following three-implementation plans, DSG is in cycles.) Examples of typical calculations to determine when an airplane would need to be surveyed are contained in Appendix 8.

(1) For an airplane that has not reached 75% DSG on Dec. 18, 2009. The operator must perform the survey at the first D-check after 75% DSG, not to exceed DSG. A "D" check or equivalent means an airplane maintenance visit where all the major structural inspections are performed. In some cases this may be a formal "D" check or, in the case of MSG-2 or 3 based maintenance program, the "D" check equivalent may be the "C" check multiple that contains the majority of the major structural inspections such as a "C-4" check sometimes called a Heavy Maintenance Visit (HMV).

(2) For an airplane that has reached 75% DSG but is less than or equal to DSG on Dec. 18, 2009. The operator must perform the survey at the next D-check, not to exceed DSG or 6 years whichever is greater.

(3) For an airplane that has exceeded DSG, the survey should be accomplished before the time limit of the next "D" check, or 6 years, which ever is earlier. Operators should have a procedure in place to prorate airplane surveys in order to evenly spread out the surveys that need to be accomplished over the six-year time frame.

e. Implementation Techniques. Use one of the two techniques below to implement DTI for repairs:

(1) The first technique involves incorporation of DT data directly into the operator's maintenance program.

(2) The second technique involves an alternative to tracking individual repairs. In this approach, incorporate the DTI as part of an operator's routine maintenance program. This approach is well suited for operators of large fleets and would entail evaluating repairs at predetermined planned maintenance visits as part of the maintenance program. This technique would require the operator to choose an inspection method and interval using an FAA-approved DTE. Use the regular FAA-approved maintenance or inspection program for repairs where the inspection requirements utilize the chosen inspection method and interval. Repairs added between the predetermined maintenance visits, including Category B and C repairs installed at remote locations, should have a threshold greater than the predetermined maintenance visit. It may also be individually tracked to account for the repair's unique inspection method and interval requirements. This would ensure the airworthiness of the structure until the next predetermined maintenance visit, when the repair would be evaluated as part of the repair maintenance program.

Category B or C repairs where inspection requirements are not fulfilled by the chosen inspection method and interval would need additional attention. These repairs would either require upgrading to allow utilization of the chosen inspection method and interval, or individually tracking to account for the repair's unique inspection method and interval requirements.

Note: DTI thresholds and repeat intervals for individual repairs cannot be exceeded without FAA approval.

304. EXISTING OPERATOR RESPONSIBILITIES.

a. Reporting Requirements. There are no added reporting requirements associated with the AASFR. However, the FAA encourages operators to report significant findings to the type certificate holders to ensure that prompt fleet action is taken. Existing reporting requirements under 14 CFR § 121.703 still apply.

b. Recordkeeping Requirements. Once the Operator receives approval for the Implementation Plan, include the list of the required inspections and their status in the records review requirements of §§121.368 and 129.33. Existing recordkeeping requirements are still applicable.

c. Transfer of Airplanes after December 20, 2010. After December 20, 2010, before adding an airplane to an air carrier's operations specifications or operator's fleet, the following should apply:

(1) For airplanes previously operated under an FAA-approved maintenance program, the new operator may use either the previously PMI approved Operator Implementation Plan or their own PMI approved Implementation plan.

(2) For airplanes not previously operated under an FAA-approved

maintenance program, the operator develops and implements an Operator Implementation Plan. If the airplane's DSG and compliance times are exceeded, accomplish any outstanding DTI according to a schedule approved by the PMI.

d. Operation of Leased Foreign-Owned Airplanes. Acquisition of a leased foreign-owned airplane for use in operations under 14 CFR parts 121, or 129 will require the certificate holder to develop and implement an Operator's Implementation Plan

e. Maintenance Program Changes. When revising a maintenance program and the continued airworthiness of repairs to fatigue critical structure is dependent on that program, the operator must evaluate the impact of the change on continued airworthiness. For example, the maintenance program inspection intervals may determine Category A repairs (Ref AC 120-73, Stage 2: Repair Classification). If revising the maintenance program in a manner that changes the inspection intervals, the operator must assess that effect on repairs that are Category A.

305. FAA PMI APPROVAL OF OPERATOR'S IMPLEMENTATION PLAN.

The certificate holder's Principal Maintenance Inspector (PMI) or other airworthiness inspector is responsible for approving the means for incorporation of the DT data for repairs into a certificate holder's FAA-approved maintenance program. An operation specification revision will show approval of the plan.

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CHAPTER 4. ADMINISTRATIVE REQUIREMENTS

400. ADVISORY CIRCULAR AVAILABILITY

HOW DO I GET A COPY OF THE PUBLICATIONS REFERRED TO IN THIS AC?

a. The CFR and those ACs for which a fee is charged may be obtained from the Superintendent of Documents at the following address. A listing of the CFR and current prices is located in AC 00–44, *Status of Federal Aviation Regulations*, and a listing of all ACs is found in AC 00–2, *Advisory Circular Checklist.*
Superintendent of Documents
P.O. Box 371954
Pittsburgh, PA 15250–7954

b. To be placed on our mailing list for free ACs, contact—
U.S. Department of Transportation
Subsequent Distribution Office
SVC–121.23
Ardmore East Business Center
3341Q 75th Avenue
Landover, MD 20785

c. You may view and print the CFR and Aircraft Certification Service and Flight Standards Service ACs on the FAA Web page at http://www.airweb.faa.gov/rgl.

401. WHO DO I CONTACT FOR MORE INFORMATION ABOUT THIS AC?

For information concerning this AC, contact the Transport Airplane Directorate, ANM-115 at 425-227-2116.

402. WHO DO I SUBMIT COMMENTS TO ABOUT THIS AC?

Submit direct comments regarding this AC to—
U.S. Department of Transportation
Federal Aviation Administration
Aircraft Maintenance Division, AFS-300
800 Independence Avenue SW.
Washington, DC 205

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APPENDIX 1. RELATED REGULATIONS AND DOCUMENTS

The following is provided as a means to access current rules and regulations together with previous ARAC Recommendations from the AAWG. Documents noted by an (*) are available at the following web site.

http://www.faa.gov

1. Title 14 of the Code of Federal Regulations (14 CFR): The following Regulations are referenced in this AC:

a. Part 21, §21.101*
b. Part 25, §§ 25.571*, 25.1529*
c. Part 43, §§ 43.13*, 43.16*
d. Part 91, § 91.403*
e. Part 121, §§ 121.368*, 121.370*, 121.370a*
f. Part 129, §§ 129.16*, 129.32*, 129.33*

2. Advisory Circulars (AC): The following Advisory Circulars are reference in this AC:

a. AC 21.101-1, Change Product Rule*
b. AC 25.571-1, Damage Tolerance and Fatigue Evaluation of Structure*
c. AC 25.571-1A, Damage Tolerance and Fatigue Evaluation of Structure*
d. AC 25.571-1B, Damage Tolerance and Fatigue Evaluation of Structure*
e. AC 25.571-1C, Damage Tolerance and Fatigue Evaluation of Structure*
f. AC 25.1529-1, Instructions for Continued Airworthiness of Structural Repairs on Transport Airplanes*
g. AC 91-56A, The Continued Airworthiness of Older Airplanes*
h. AC 91-56B, The Continued Airworthiness of Older Airplanes*
i. AC 120-73, Damage Tolerance Assessment of Repairs to Pressurized Fuselages*

3. Other Documents referred to in this AC:

a. A Final Report of the AAWG – Continued Airworthiness of Structural Repairs*
b. A Report of the AAWG – Recommendations for Regulatory Action to Prevent Widespread Fatigue Damage in the Commercial Airplane Fleet*
c. A Report of the AAWG - Recommendations For Regulatory Action To Enhance Continued Airworthiness Of Supplemental Type Certificates*
d. Repair Assessment Guidelines, FAA Approved Model Specific Guideline Documents**
e. FAA Approved Model Specific Supplemental Inspection Documents**
f. ATA Report 51-93-01***
g. ATA Response to FAA Docket 1999-5401 Dated May 5, 2003***
h. Federal Register/Vol. 69, No. 146/Friday, July 30, 2004/Rules and Regulations Fuel Tank Safety Compliance Extension (Final Rule) and Aging Airplane Program Update (Request for Comments). Page 45936*

** Various manufacturers publish these documents. Please contact those manufacturers to determine the general availability of the documents.

*** Please contact the ATA.

APPENDIX 2. DEFINITIONS AND ACRONYMS

a. **Supplemental Structural Inspection Program (SSIP)** is a damage-tolerance-based inspection program. SSIPs only address the structure identified by the type certificate holder using the guidance contained in AC 91-56.

b. **Instructions for Continued Airworthiness (ICA)** are maintenance actions defined by the TC or STC holder and delivered with the airplane in accordance with 14 CFR 25.1529. ICA are documented information that includes the applicable methods, inspections, processes, procedures and airworthiness limitations.

c. **Airworthiness Limitations Section (ALS)** is a collection of mandatory maintenance actions required for airplane structure and fuel tank system. For structural maintenance actions, the ALS includes structural replacement times, structural inspection intervals, and related structural inspection procedures.

d. **Repair Assessment Program (RAP)** is a program that incorporates damage tolerance based inspections for repairs to the fuselage pressure boundary structure into the operators FAA approved maintenance and/or inspection program as required by 14 CFR 121.370.

e. **Design Approval Holder (DAH)** is a person that holds a type design approval for an airplane or any FAA approved data necessary to repair, alter, or modify airplane structure.

f. **Type Design** consists of drawings and specifications; information on dimensions, materials, and processes; airworthiness limitations; and any other data necessary to describe the design of the product.

g. **Damage Tolerance Evaluation (DTE)** a process that leads to a determination of continuing airworthiness inspections and other procedures for a repair using damage tolerance procedures as defined in AC 25.571-1, 1A, 1B, or 1C.

h. **Damage Tolerance Inspections (DTI)** inspections and other procedures that are a result of a DTE process. These should include the location of the airplane structure to be inspected, and the threshold and interval associated with those inspections, inspection method, and/or, in some cases, removal limits.

i. **DT data** refers collectively to the DTE processes and DTI needed by an operator to address repairs as required by the AASFR.

j. **Repair** is the restoration of an item to a serviceable condition in conformity with an approved standard.

k. **Airplane structural configuration** is the approved original type certificate design,_including any model variations or derivatives; and alterations or replacements mandated by AD.

l. **Structures Task Group (STG)** is a model specific group. The STG comprises design approval holders and operators who are responsible for the development of aging airplane mod specific programs. It also includes regulatory authorities who approve and monitor those programs.

m. **Alteration or modification** is an FAA-approved design change that is made to an airplane. Within the context of this AC these terms are considered synonymous. Both terms are purposely used herein to be all inclusive of any design change and to avoid potential misinterpretation of intent of these terms.

n. **Amended Type Certificate (ATC)** is a process where the original OEM may modify the airplane and have the modification approved by amending the original type certificate under 14 CFR 21. 177.

o. **Design Service Goal (DSG)** is the period of time (in flight cycles/hours) established at design and/or certification during which the principal structure will be reasonably free from significant cracking.

p. **Repair Assessment Guidelines (RAG)** a document that provides a means to establish a damage tolerance based inspection program for repairs to detect damage that may develop in a repaired area before that damage degrades the load carrying capability of a structure below the levels required by the applicable airworthiness standards.

APPENDIX 3. BACKGROUND

a. Fatigue is recognized as a significant threat to the continued airworthiness of airplanes. This is because even small fatigue cracks can significantly reduce the strength of the structure they are in. Consistent with this the airworthiness standards for certification of new transport category airplanes have always addressed fatigue with the intent of avoiding catastrophic failures because of fatigue throughout the operational life of the airplane. However these requirements have not remained unchanged. They have evolved over-time as the relevant knowledge base has increased because of service experience, specific incidents and accidents that have occurred and technological advances in design, analysis, testing, manufacturing, and inspection.

b. One of the first significant changes in the standards occurred in March 1956 with revision of the Fatigue Evaluation requirements contained in CAR 4b.270 to add "Fail-safe strength" as an option to the "Fatigue strength" approach for addressing fatigue. Motivation for this change was the realization that precluding fatigue cracking from occurring might not always be possible and therefore, as an option, the structure may be designed to survive cracking even if it occurred. The fatigue strength approach tries to achieve a design where fatigue cracking is not probable within the operational life of the airplane. The fail-safe approach assumed that cracking could occur while maintaining a specified minimum strength after a "fatigue failure or obvious partial failure" had occurred. The efficacy of the fail-safe approach was not only dependent on the structure keeping the specified minimum strength with the fatigue damage present but also on the finding the damage during normal maintenance. As applied, the fail-safe approach emphasis is on redundancy as opposed to fatigue performance while inspectability is assumed and not quantified. The fail-safe option was the predominate approach chosen for the most large transport category airplanes certified in the 1960s and 1970's.

c. Another significant change in the airworthiness standards for fatigue occurred in October 1978 with amendment 25-45 with revision and deletion of §§ 25.571 and 25.573 of 14 CFR Part 25 respectively. This change involved removing the fail-safe option entirely and establishing a new requirement to develop damage tolerance based inspections wherever practical. The fatigue strength approach, as a default option, is used only if the damage tolerance approach is impractical. The motivation for the 1978 change is a recognition, based on mounting evidence, the fail-safe approach applied up to that point is not reliable and will not achieve the desired level of safety. Specific areas of concern with the fail-safe approach included the loss of fail-safety with age. This is because of the increased probability of cracking in the structure adjacent to the fatigue failure or obvious partial failure and the lack of directed inspections and quantification of residual life with the assumed damage present. It was agreed at the time that more emphasis is needed on where and how fatigue cracking could occur in the structure and on quantifying crack growth and residual strength characteristics. This includes damage tolerance characteristics and development of effective inspection protocols such as where, when, how and how often to inspect. The 1978 changes achieved this for new transport category airplane certification.

d. The same events and reasoning that drove the changes to airworthiness standards for new airplane also influenced the strategy adopted to ensure the continued airworthiness of the existing fleet. There was increasing concern about existing older airplanes certified according to the fail-safe requirements of CAR 4b.270. Eleven large transport models were specifically identified as needing the most attention. It was decided to develop damage tolerance based inspection programs and implement them for these airplanes. These inspections supplement existing maintenance inspections and thus these programs were referred to as Supplemental Structural Inspection Programs (SSIPs). The inspection requirements were documented in Supplemental Inspection Documents (SIDs). It was also agreed that SIDs would be developed by the Original Equipment Manufacturers on a voluntary basis and then mandated by Airworthiness Directive (AD). The CAA published guidance for developing the SSIPs in Airworthiness Notice No. 89, Continuing Structural Integrity of Transport Aeroplanes dated August 23, 1978 and by the FAA in Advisory Circular No. 91-56, Supplemental Structural Inspection Program for Large Transport Category Airplanes dated May 6, 1981. Subsequently SSIPs were developed and mandated by AD for the eleven aging models. Little or no consideration was given to repairs, alterations or modifications (RAMs). Airworthiness Directives that mandated the SSIP programs addressed some RAMs.

e. In April 1988 one of the eleven aging models, for which a SSIP had been developed and mandated by AD, suffered major structural damage to its pressurized fuselage structure because of undetected fatigue cracking of the baseline primary structure. This accident was attributed in part to the aging of the airplane involved. It precipitated actions culminating regulations aimed at avoiding catastrophic failures from fatigue in existing and future airplanes.

f. In response to the April 1988 accident the FAA sponsored a conference on aging airplane a establishing a task force representing the interests of the airplane operators, airplane manufacturers, regulatory authorities and other aviation representatives. In addition, other recommendations from this task force specifically recommended consideration of damage tolerance for repairs. In direct response to these recommendations changes to parts 91, 121, 125 and 129 of Title 14 of the CFR occurred in April 2000. This required operators to incorporate damage tolerance based inspections for existing and future repairs to the fuselage pressure boundary for the eleven aging models previously identified. This did not address other models and repairs to other structure.

g. The April 1988 accident also precipitated congressional legislation. In October 1991 Congress enacted Title IV of Public Law 102-143, the "Aging Airplane Safety Act of 1991" (AASA). Two key elements of the AASFR are as follows:

(1) Required "the Administrator to make such inspections and conduct such reviews of maintenance and other records of each airplane used by an air carrier to provide air transportation as may be necessary to determine that such is in a safe condition and is properly maintained for operation in air transportation".

(2) Specified that an air carrier must be able to demonstrate as part of the inspection "that maintenance of the airplane's structure, skin, and other age sensitive parts and components have been adequate and timely enough to ensure the highest level of safety".

h. Although the AASA did not define specifics of what had to be done, the one clear intent was to avoid catastrophic failures because of fatigue throughout the operational life of each affected airplane. Consistent with this, and the damage tolerance requirements adopted in 1978 for new transport category airplanes, FAA initiated rulemaking that would require broader implementation of damage tolerance based structural inspection programs. This would apply to almost all multiengine airplanes used in scheduled passenger service. Additionally the intent was to address all structure where fatigue cracking could result in catastrophic failure.

i. In response to the AASA, the FAA rulemaking efforts eventually resulted in the issuance of the Aging Airplane Safety Interim Final Rule (AASIFR) on December 6, 2002. This rule required implementation of damage tolerance based inspection programs for all airplanes operated under 14 CFR 121 and 129 operations. Also all multi-engine airplanes engaged in 129 or 135 operations that were initially certificated with 10 or more passenger seats by December 8, 2007. Airplanes operated between any point within the State of Alaska and any other point within the State of Alaska is exempt.

j. The AASIFR was subsequently amended and finalized on February 2, 2005, to the Aging Airplane Safety Final Rule (AASFR). The revised rule requires implementation of damage tolerance based inspection programs by December 20, 2010. This applies to airplanes engaged in 121 or 129 operations with type certificated seating capacity of 30 or more or a payload capacity of 7,500 pounds or greater. Airplanes operated within Alaska remain exempt. Although the scope has been reduced, it still affects the majority of airplanes engaged in scheduled passenger carrying service. Relative to damage tolerance based inspection programs it raises the level of safety on the existing fleet of affected airplanes to the same level required for current transport category airplane type design approvals.

APPENDIX 4. APPROVAL PROCESS FOR NEW REPAIRS

In the past, AC 1529-1 allowed a two-stage approach in approving repairs to PSEs. The two-stage approach consisted of:

- Type design strength requirements of section 25.305 before return to service
- Damage tolerance evaluation performed and DT data developed to demonstrate compliance with section 25.571 within 12 months of return to service.

The guidance material in AC 1529-1 is now embodied in this guidance material and modified to allow a three-stage approach now commonly used in the industry.

The DT data includes inspection requirements (i.e. inspection threshold, inspection method and inspection repeat interval) or other procedures (e.g. replacement/modification time) if inspections are shown to be impractical. The required data may be submitted all at once, prior to the airplane return to service, or it may be submitted in stages. The following three-stage approval process is available that involves incremental approval of engineering data to allow an airplane to return to service before all the engineering data previously described is submitted. The three stages are described as follows:

a. The first stage is approval of the static strength data and the schedule for submittal of the DT data. This approval is required prior to returning an airplane to service. The submittal of the DT data should generally occur prior to 12 months from when the airplane was returned to service.

b. The second stage is approval of the DT data. The DT data should be submitted in accordance with the schedule approved in the first stage. The DT data might only contain the threshold where inspections are required to begin as long as the operator can demonstrate that a process is in place to acquire the required inspection technique and interval before the threshold is reached. In this case the submittal and approval of the remaining DT data may be deferred to the third stage.

c. The third stage is approval of the DT data not submitted and approved in the second stage. This would typically involve the inspection method and the repeat intervals. This data would need to be submitted and approved prior to the inspection threshold being reached. Operation beyond the threshold would not be allowed unless the data is submitted and approval obtained.

APPENDIX 5. ASSESSMENT OF EXISTING REPAIRS

A DTI assessment process consists of the following steps:

a. Airplane Repair Survey. A survey will be used to identify existing repairs and repair configurations on fatigue critical structure and provide a means to categorize those repairs. The survey would apply to all affected airplanes, as defined in the implementation plan, in an operator's fleet using the process contained in the Compliance Document. The procedure to identify repairs that require DTE should be developed and documented in the Compliance Document using 14 CFR 25.571 and AC 25.571-1x (dependant on airplane certification level) together with additional guidance specific to repairs, such as:

- **(1)** Size of the repair
- **(2)** Repair configuration
  - **(a)** SRM standards
  - **(b)** Other
- **(3)** Proximity to other repairs
- **(4)** Potential affect on fatigue critical baseline structure
  - **(a)** Inspectability (access and method)
  - **(b)** Load distribution

b. Identification and Disposition of repairs requiring immediate action. Certain repairs may not meet minimum requirements based on its condition such as cracking, corrosion, dents, or inadequate design. Use the guidance provided in the Compliance Document to identify these repairs and once identified take appropriate corrective action. In some cases, modifications may need to be made before further flight. The operator should consider establishing a fleet campaign if such repairs may have been installed on other airplanes. Note: Additional FAA Certificate Maintenance Office (CMO) coordination and approval, or regulatory action may be required in these cases.

c. DTI Development. This includes the development of the appropriate maintenance plan for the repair under consideration. During this step determine the inspection method, threshold and repeat interval. Determine this information from existing guidance information as documented in the Compliance Document, or from the results of an individual damage tolerance evaluation performed in according to AC 25.571. Then determine the feasibility of an inspection program to maintain continued airworthiness. If the inspection program is practical, incorporate the DTI into the individual airplane maintenance program. If the inspection is either impractical or impossible, incorporate a replacement time for the repair into the individual airplane maintenance program. The three-stage approach discussed in Appendix 4 may be used if appropriate.

APPENDIX 6. REPAIRS TO REMOVABLE STRUCTURAL COMPONENTS

This Appendix provides guidance on handling DT data development and implementation for existing and new repairs to fatigue critical structure on removable structural components. In summary, the guidance covers:

- Methods of determining or assigning the age (hours/cycles) to a removable structural component when its original life history is unknown.
- Guidance on tracking of removable components that contain fatigue critical structure.
- Methods and schedules for developing and implementing DT data for repairs to removable components that contain fatigue critical structure.
- Implementation options for removable components that contain fatigue critical structure.

Other methods than those given below for determining the age of a component or tracking parts may be used if approved by the PMI as part of the Operator's Implementation Plan.

a. Determining the Age of a Component. Determining an actual component age or assigning a conservative age will provide flexibility and reduce operator burden when implementing DT data for repairs to structural components. In some cases, the actual component age may be determined from records. If the actual age cannot be determined this way, the component age may be conservatively assigned using one of the following fleet leader concepts depending upon the origin of the component:

(1) If part times are not available, but records indicate that no part changes have occurred, airplane cycles/hours can be used.

(2) If no records are available and the parts could have been switched from one or more older airplanes under the same maintenance program, it should be assumed that the time on any part is equal to the oldest airplane in the program. If this is unknown, the time should be assumed equal to the same model airplane that is the oldest or has the most hours/flight cycles in the world fleet.

(3) A manufacturing date marked on a component may also be used to establish the component's age. This can be done by using the above reasoning and comparing it to airplanes in the affected fleet with the same or older manufacturing date.

If none of these options can be used to determine or assign a component age or hours/cycles, a conservative implementation schedule can be applied in Paragraph c, below, for the initial inspection if required by the DT data.

b. Tracking. An effective, formal control or tracking system should be established for removable structural components that are subject to this rule. This will help ensure compliance with maintenance program requirements specific to repairs installed on an affected removable structural component. Paragraph d, below, does provide options that could be used to alleviate some of the burdens associated with tracking all repairs to affected removable structural components.

c. Developing and Implementing DT Data:

(1) Existing Repairs – Components Installed prior to December 20, 2010. Accomplish the initial repair assessment of the affected component at the same time as the airplane level survey for the airplane on which the component is installed (Step b, above). Develop the DT data per the process given in Step 3 of Appendix 5 and incorporate the DTI into the maintenance program. Accomplish the first inspection on the affected component according to the following schedule:

(a) If the actual repair installation age, hours/cycles is known, use that to accomplish the first inspection against the component. Repeat inspect at the intervals given for the repair.

(b) If the repair installation age, hours/cycles is unknown, but the component age, hours/cycles is known or can be assigned conservatively, use the component age, hours/cycles to accomplish the first inspection against the component. Repeat inspect at the intervals given for the repair against the component.

(c) As an option, accomplish the first inspection on the affected component at the next C-check (or equivalent interval) following the repair assessment. Repeat inspect at the intervals given for the repair against the component.

(2) Existing Repairs – Components Installed from Storage after December 20, 2010. For components installed from storage after December 20, 2010 that have not previously had DTE performed and DTI implemented, develop and implement DT data as follows:

(a) If the time on the component (hours/cycles) is known, or can be conservatively assigned, perform the following:

- **i** Survey the component,
- **ii** Disposition the repair(s)
- **iii** Implement the DTI in accordance with the schedule given for an airplane in Chapter 207 b(1), using the component's age
- **iv** Accomplish the first inspection using the actual repair age, hours/cycles if known. If the repair age is not known, use the component age. Repeat inspect at the intervals given for the repair against the component.

(b) If the time on the component, hours/cycles is unknown and cannot be assigned, accomplish the initial repair assessment of the affected component prior to installation.

i Develop the DT data per the process given in Chapter 207 b(1).

ii Incorporate the DTI into the maintenance program.

iii Accomplish the first inspection on the affected component at the next C-check (or equivalent interval) following the repair assessment.

iv Repeat inspect at the intervals given for the repair against the component.

(3) New Repairs. New repairs to fatigue critical structure on removable structural components installed beginning December 21, 2010, and thereafter, must have DTE performed and DTI implemented according to the process described in Appendix 4, "Approval Process for New Repairs". The initial and repeat inspections are accomplished at the intervals given for the repair against the component.

d. Implementation Options to Help Reduce Tracking Burden. The following implementation techniques could be used to alleviate some of the burdens associated with tracking repairs to affected removable structural components. These techniques, if used, would need to be included in the Operator's Implementation Plan(s) and may require additional FAA-ACO approval and DAH input for DTI.

(1) Upgrading Existing Repairs. As an option, existing repairs may be removed and replaced to zero time the DTI requirements of the repair and establish an initial tracking point for the repair. Normally, this would be done at or before the survey for maximum benefit. The initial and repeat inspections for the upgraded repair would then be accomplished at the intervals given for the repair against the component.

A repair could also be upgraded to one whose inspection requirements and methods are already fulfilled by an Operator's regular FAA-approved maintenance or inspection program (Section 302, Step d., Implementation Techniques). That repair would then be repetitively inspected at each routine inspection interval applicable to the repair. Specific tracking would not be required because that area of the airplane would already be normally inspected on each airplane in the fleet as part of the existing approved maintenance program. If the Operator's program intervals were changed, the affect on requirements for specific tracking would have to be re-evaluated.

(2) Special Initial and/or Routine Inspections. As an option, existing repairs may have special initial inspections accomplished during the survey to zero time the DTI requirements of the repair and establish an initial tracking point for the repair.

In addition, special routine inspections could be defined for typical repairs that could be applied at a normal interval. In this case, an operator could check the affected components on each aircraft for this type of a repair at the defined interval. If the repair were found, the special inspection would be applied to ensure its airworthiness until the next scheduled check. This would alleviate the need to specifically track affected components for every repair, especially typical ones.

The development of inspection processes, methods, applicability and intervals would most likely require the assistance of the DAH for the fatigue critical structure in question. In all circumstances, the data must be approved by the FAA-ACO.

APPENDIX 7. PROGRAM IMPLEMENTATION EXAMPLES

The following are provided to assist the operator in understanding how the program should be implemented. Two examples are given, one covers airplanes below 75% DSG on December 18, 2009, and the other is for airplanes beyond DSG on December 18, 2009.

a. Airplane Below 75% DSG on December 18, 2009

Consider the following:

(1) Airplane Total Cycles on December 18, 2010 – 55,000
(2) DSG = 75,000 Cycles, 75% DSG – 56,250 Cycles
(3) Time of last "D"-Check Equivalent – 53,000 Cycles
(4) 8 Year "D"- check Equivalent – 360 Days/Year, 4 cycles/day = 11,680 Cycles

The survey would be performed after the airplane reaches 56,250 cycles and would be due before 64,680 cycles, but in any case would be required before the airplane reached 75,000 cycles.

b. Airplane Beyond DSG on December 18, 2009

Consider an airplane that has accumulated 80,000 cycles as of December 18, 2009, a DSG of 75,000 cycles. The airplane is currently on an 8 year "D" check equivalent and the last "D"-check was performed in January 2009 at 78,540 cycles. The survey would need to be performed prior to the airplane accumulating 90,220 cycles or 6 years whichever occurs sooner, based on the airplane utilization of 4 cycles/day, a 360-day year, and a maximum accumulated cycles of 81,460 as of December 20, 2010.

Appendix C: AAWG Recommendations on AC 91-56B

U.S. Department
of Transportation
**Federal Aviation
Administration**

Advisory Circular

AAWG ANNOTATED VERSION – Includes AAWG Recommendations from ARAC Tasking Review

Subject: CONTINUING STRUCTURAL INTEGRITY PROGRAM FOR AIRPLANES	**Date: XX/XX/02** **Initiated By: ANM-115**	**AC No: 91-56B** **Change:**

1. PURPOSE. This Advisory Circular (AC) provides guidance material to type certificate holders (TCH) and operators for use in developing a continuing structural integrity program to ensure safe operation of older airplanes throughout their operational life.

2. CANCELLATION. AC 91-56A, Continuing Structural Integrity Program for Large Transport Category Airplanes dated April 29, 1998, is canceled.

3. RELATED REGULATIONS AND DOCUMENTS.

a. Title 14 of the Code of Federal Regulations (14 CFR):

(1) Part 25, § 25.571.

(2) Part 91, § 91.403.

(3) Part 43, § 43.16.

AAWG Changes Highlighted:
Additions shown in *Italics*
Deletions shown in ~~Strikethrough~~

(4) Part 121, §121.368, §121.370, and §121.370(a).

(5) Part 129, §129.16, §129.32, and §129.33.

b. Advisory Circulars (AC):

(1) AC 25.571-1, Damage Tolerance and Fatigue Evaluation of Structure.

(2) AC 91-60, The Continued Airworthiness of Older Airplanes.

(3) AC 120-73, Damage Tolerance Assessment of Repairs to Pressurized Fuselages.

(4) AC 120-AAWG, Damage Tolerance Inspections for Repairs.

4. DEFINITIONS. Terms included in this document are defined as follows:

a. Supplemental Structural Inspection Program (SSIP).

(1) This guidance material is traditionally applied to the eleven large transport airplane models (Airbus Model A300; British Aerospace BAC 1-11; Boeing Models B-707/720, B-727, B-737, B-747; McDonnell Douglas DC-8, DC-9/MD-80, DC-10; Fokker F28; and Lockheed Model L-1011 series airplanes) which were certified under the fail-safe and fatigue requirements of Civil Air Regulations (CAR) 4b or 14 CFR Part 25 of the Federal Aviation Regulations (FAR), prior to Amendment 25-45, and which have a maximum takeoff gross weight greater than 75,000 pounds operated under Subpart D of 14 CFR Parts 91, 121, and 125.

(2) The promulgation of the "Aging Airplane Safety" rule expanded the requirement for damage tolerance-based SSIPs beyond the above noted eleven models to include:

- All airplanes operated under Subpart D of 14 CFR Part 121;
- All U.S.-registered multiengine airplanes operated under 14 CFR Part 129 certificated with 10 or more passenger seats; and
- All multiengine airplanes used in scheduled operations under 14 CFR Part 135 certificated with 10 or more passenger seats.

(3) Guidance material for all U.S.-registered multiengine airplanes operated under Part 129 certificated with 9 or less passenger seats and all multiengine airplanes operated under Part 135 certificated with 9 or less passenger seats required by the "Aging Airplane Safety" rule to develop a service history based SSIPs is provided in AC 91-60.

b. Mandatory Modification Program. This guidance material is applicable to the eleven large transport airplane models (Airbus Model A300; British Aerospace BAC 1-11; Boeing Models B-707/720, B-727, B-737, B-747; McDonnell Douglas DC-8, DC-9/MD-80, DC-10; Fokker F28; and Lockheed Model L-1011 series airplanes) that are required by airworthiness directives to modify or replace aging structures with known cracking problems.

c. Corrosion Prevention and Control Program (CPCP). This guidance material is applicable to the airplanes that are required by airworthiness directives (AD) to maintain the corrosion on their airplanes to an acceptable level.

d. Repair Assessment Program. This guidance material is applicable to the eleven large transport airplane models (Airbus Model A300; British Aerospace BAC 1-11; Boeing Models B-707/720, B-727, B-737, B-747; McDonnell Douglas DC-8, DC-9/MD-80, DC-10; Fokker F28; and Lockheed Model L-1011 series airplanes) that are required by operational rules to incorporate repair assessment guidelines for the fuselage pressure boundary in their FAA-approved maintenance or inspection program.

> **NOTE: The "Evaluation for Widespread Fatigue Damage" will be mandated in a future rulemaking activity.**

5. BACKGROUND.

a. Service experience has demonstrated that there is a need to have continuing updated knowledge concerning the structural integrity of transport airplanes, especially as they became older. The structural integrity of these airplanes is of concern since factors such as fatigue cracking and corrosion are time dependent and knowledge concerning them can best be assessed on the basis of real time operational experience and the use of the most modern tools of analysis and testing.

b. The Federal Aviation Administration (FAA), TCH, and operators are continually working to maintain the structural integrity of older airplanes. Traditionally, this has been accomplished through an exchange of field service information and subsequent changes to inspection programs, and by the development and installation of modifications on particular aircraft. However, increased utilization, longer operational lives, and the high safety demands imposed on the current fleet of airplanes indicate the need for a program to ensure a high level of structural integrity for all airplanes. Accordingly, the inspection and evaluation programs outlined in this AC are intended to ensure a continuing structural integrity assessment by each airplane TCH and the incorporation of the results of each assessment into the maintenance program of each operator.

6. SUPPLEMENTAL STRUCTURAL INSPECTION PROGRAMS.

a. Initiation and Implementation. The TCH, in conjunction with operators, is expected to initiate development of a SSIP for each airplane model. Such a program must be implemented before analysis, tests, and/or service experience indicates that a significant increase in inspection and/or modification is necessary to maintain structural integrity of the airplane.

b. Timeline to Begin Initiation. The SSIP should be accomplished in accordance with the timeline provided in the "Aging Airplane Safety" rule. In the absence of other data as a guideline, the program should be initiated no later than the time when the high-time or high-cycle airplane in the fleet reaches one half its design service goal. This should ensure that an acceptable program is available to the operators when needed. The program should include procedures for obtaining service information, and assessment of service information, available test data, and new analysis and test data. A Supplemental Structural Inspection Document (SSID) should be developed, as outlined in Appendix 1, from this body of data.

c. Submission of the SSID. The recommended supplemental inspection program, along with the criteria used and the basis for the criteria, should be submitted to the cognizant FAA Aircraft Certification Office for review and approval. The supplemental program should be adequately defined in the SSID and presented in a manner that is effective. The SSID should include:

(1) The type of damage being considered;

(2) Likely sites;

(3) Inspection access;

(4) Threshold;

(5) Interval;

(6) Method and procedures;

(7) Applicable modification status and/or life limitation; and

(8) Types of operations for which the SSID is valid.

d. FAA Review and SSID Acceptance. The FAA review of the SSID will include both engineering and maintenance aspects of the proposal. Since the SSID is applicable to all operators and is intended to address potential safety concerns on older airplanes, it will be made mandatory under the existing AD system or in accordance with the "Aging Airplane Safety" rule. In addition, any service bulletin or other service information publications found to be essential for safety during the initial SSID assessment process should be implemented by AD action. Service bulletins or other service information publications revised or issued as a result of in service findings resulting from implementation of the SSID should be added to the SSID or implemented by separate AD action, as appropriate.

NOTE: In the event an acceptable SSID cannot be obtained on a timely basis, the FAA may impose service life, operational, or inspection limitations to ensure structural integrity.

e. SSID Revisions. The TCH should revise the SSID whenever additional information shows a need. The original SSID will normally be based on predictions or assumptions (from analyses, tests and/or service experience) of failure modes, time to initial damage, frequency of damage, typically detectable damage, and the damage growth period. Consequently, a change in these factors sufficient to justify a revision would have to be substantiated by test data or additional service information. Any revision to SSID criteria and the basis for these revisions should be submitted to the FAA for review and approval of both engineering and maintenance aspects.

f. Baseline Structure Inspection Program. The operators will be expected to accomplish a damage tolerance based inspection program of all *alterations, modifications and repairs made to aircraft structure and STCs that is susceptible to fatigue cracking that could contribute to a catastrophic failure. This is to be done in accordance with the timelines established in the "Aging Airplane Safety" rule.* ~~major repairs, alterations, or modifications to baseline structure in accordance with the timelines established in the "Aging Airplane Safety" rule.~~ The baseline structure is defined as that airplane structure that was originally built by the TCH. The results must be presented to the cognizant Aircraft Certification Office for review and approval, with type certificate responsibility for the airplane model being considered. Traditionally, the ADs that have mandated SSIPs on older airplanes have addressed repairs, alterations, and modifications that affect principal structural elements (PSE) and the "Repair Assessment for Pressurized Fuselages" rule addressed repairs to the fuselage pressure boundary (fuselage skin, door skin, and bulkhead webs), but the "Aging Airplane Safety" rule requires that all *alterations, modifications and repairs made to aircraft structure and STCs that are susceptible to fatigue cracking that could contribute to catastrophic failure be considered.* ~~major repairs, alterations, and modifications to baseline structure be considered.~~

7. MANDATORY MODIFICATION PROGRAM.

a. The mandatory modification program was based on the premise that to ensure the structural integrity of older airplanes, there should be less reliance on repetitive inspections when certain criteria exist. These criteria included:

- The likelihood that known structural cracking problems exist and are not just theoretical or predicted.
- The consequences of failing to correct the problem must be catastrophic. This means that the structural element involved must be a PSE or other primary structure.
- The cracks must be difficult to detect during regular maintenance.
- Other considerations are that the areas to inspect are difficult to access, nondestructive testing (NDT) methods are unsuitable, or human factors of inspection are so adverse that crack detection may not be sufficiently dependable to assure safety.

b. The structural modification programs were invoked on the original eleven models (Airbus Model A300; British Aerospace BAC 1-11; Boeing Models B-707/720, B-727, B-737, B-747; McDonnell Douglas DC-8, DC-9/MD-80, DC-10; Fokker F28; and Lockheed Model L-1011 series airplanes) by ADs. Each of the TCHs reviewed their service bulletins with the FAA to determine which areas of structure needed terminating modifications to inspections. The revised service bulletins that included those terminating modifications were then grouped in a document and mandated, or the service bulletin was mandated individually.

c. *The Aging Airplane Safety Final Rule requires that all modifications that are susceptible to fatigue cracking that could contribute to a catastrophic failure be considered.*

8. CORROSION PREVENTION AND CONTROL PROGRAM (CPCP). A CPCP is a systematic approach to controlling corrosion in the airplane's primary structure and consists of a basic corrosion inspection task, task areas, defined corrosion levels, and compliance times. The objective of a CPCP is to limit the material loss due to corrosion to a level necessary to maintain airworthiness.

a. The CPCPs were mandated by ADs for certain large transport category airplanes (Airbus Model A300; British Aerospace BAC 1-11; Boeing Models B-707/720, B-727, B-737, B-747; McDonnell Douglas DC-8, DC-9/MD-80, DC-10; Fokker F28; and Lockheed Model L-1011 series airplanes) and numerous other transport category airplanes. The TCHs for these airplanes developed the CPCP document that was mandated by an AD. These corrosion programs supplemented each operator's maintenance program.

b. The corrosion programs were developed based on the premise that operators could adjust them when unacceptable corrosion levels were found. These maintenance program adjustments should preclude recurrence of unacceptable corrosion findings. Adjustments may include actions such as reduced repetitive task intervals, improved corrosion treatments or multiple corrosion inhibitor applications.

c. *Include a new paragraph that stipulates industry standard practices since CPCP rulemaking withdrawn (TBD).* ~~The FAA is considering additional rulemaking to require that maintenance or inspection programs for all airplanes operated under Part 121, all U.S.-registered multiengine airplanes operated in common carriage by foreign air carriers or foreign persons under Part 129 and all multiengine airplanes used in scheduled operations operated under Part 135 include an FAA-approved CPCP. This Notice of Proposed Rulemaking (NPRM) would give operators two years to implement a CPCP into their maintenance or inspection program. This NPRM would be issued in response to the Aging Airplane Safety Act of 1991.~~

9. REPAIR ASSESSMENT PROGRAM. The industry was given the task to develop a method for airlines to evaluate airplane repairs to determine whether they are acceptable permanent repairs incorporating damage tolerance. This program will ensure that existing repairs do not deteriorate due to accidental, fatigue, or environmental damage beyond FAA-approved levels for the remaining usage life of the airplane.

a. On January 2, 1998, an NPRM, Repair Assessment for Pressurized Fuselages, was published in the Federal Register. The proposed rule would prohibit the operation of certain large transport category airplanes (Airbus Model A300; British Aerospace

BAC 1-11; Boeing Models B-707/720, B-727, B-737, B-747; McDonnell Douglas DC-8, DC-9/MD-80, DC-10; Fokker F28; and Lockheed Model L-1011 series airplanes) operated under Parts 91, 121, 125, and 129 beyond a specified compliance time, unless the operator of those airplanes had incorporated FAA-approved repair assessment guidelines applicable to the fuselage pressure boundary (fuselage skin, door skin, and bulkhead webs) in its operation specification(s) or approved inspection program, as applicable. This rulemaking ensures that a comprehensive damage tolerance repair assessment be completed for fuselage pressure boundary repairs.

b. The final rule was published in the Federal Register on April 25, 2000 and became effective May 25, 2000. As a result of this final rule the new operating rules are Part 91, § 91.410, Part 121, § 121.370, Part 125, § 125.248, and Part 129, § 129.32. AC 120-73 provides an acceptable means of compliance with the regulations that require incorporating FAA-approved repair assessment guidelines into an operator's FAA-approved maintenance or inspection program.

10. EVALUATION FOR WIDESPREAD FATIGUE DAMAGE. The manufacturer, in conjunction with operators, is expected to initiate development of a Widespread Fatigue Damage (WFD) prediction and verification technique with the intent of precluding operation in the presence of WFD. Such a program must be implemented before analysis, tests, and/or service experience indicates that widespread fatigue damage may develop in the fleet. To ensure that an acceptable program is available to the operators when needed, development of the program should be initiated no later than the time when the high-time or high-cycle airplane in the fleet reaches three quarters of its design service goal.

a. The results of the WFD evaluation should be presented to the cognizant FAA Aircraft Certification Office for review and approval. Since the objective of this evaluation is to eliminate WFD from the fleet, it is expected that the results will include recommendations for the verification or removal of WFD as appropriate. In the case of verification inspections, the very small size of critical WFD cracks may dictate the use of new inspection techniques. It is expected that the manufacturer will work closely with operators to assure that the expertise and resources for such inspections are available when needed.

b. The FAA review of the WFD evaluation results will include both engineering and maintenance aspects of the proposal. Since WFD is applicable to all operators and is a demonstrated safety concern for older airplanes, identified inspection or modification programs will be made mandatory. In addition, any service bulletins or other service information publications that are revised or issued as a result of in-service WFD findings resulting from implementation of these programs may require separate AD action.

c. In the event an acceptable WFD evaluation is not completed on a timely basis, the FAA may impose service life, operational limitations, or inspection requirements to assure structural integrity.

d. The manufacturer should update the WFD evaluation as the fleet continues to age and as additional information shows a need. It is expected that the original recommended actions stemming from a WFD evaluation will be focused on those structural items determined to be prone to WFD that have passed, or are soon expected to reach, the age at which WFD is predicted to occur. As the fleet ages, more areas of the airplane may reach that point, and the recommended actions should be updated accordingly. Also, new service experience findings, improvements in the prediction methodology, better load spectrum data, or a change in any of the factors upon which the WFD evaluation is based may dictate a revision to the evaluation. Accordingly, associated new recommendations for service action should be developed and submitted to the FAA for review and approval of both engineering and maintenance aspects.

11. IMPLEMENTATION. Once a SSID AD is issued, operators will be in a position to amend their current structural inspection programs to comply with and account for the applicable AD. SSIDs for the above noted aging aircraft models and those derivatives that were not certified to the damage tolerance requirements will still continue to be mandated by airworthiness directives. SSIDs for the other airplanes will be incorporated in accordance with the "Aging Airplane Safety" rule and will not require airworthiness directives. ADs issued as a result of a WFD finding that require structural modification would be handled separately. In all cases, compliance will be required in accordance with the applicable regulations.

Ronald T. Wojnar
Manager, Transport Airplane Directorate
Aircraft Certification Service

APPENDIX 1

GUIDELINES FOR DEVELOPMENT OF THE SUPPLEMENTAL STRUCTURAL INSPECTION DOCUMENT

1. GENERAL.

a. The airplanes subject to this appendix were not certified to a damage tolerance requirement. However, the structure to be evaluated, the type of damage considered (fatigue, corrosion, service, and production damage), and the inspection and/or modification criteria should, to the extent practicable, be in accordance with the damage-tolerance principles of Title 14 of the Code of Federal Regulations (14 CFR) Part 25, § 25.571. An acceptable means of compliance can be found in the current version of AC 25.571-1, Damage Tolerance and Fatigue Evaluation of Structure.

b. It is essential to identify the structural parts and components that contribute significantly to carrying flight, ground, pressure, or control loads, and whose failure could affect the structural integrity necessary for the continued safe operation of the airplane. The damage tolerance or safe-life characteristics of these parts and components must be established or confirmed.

c. Analyses made in respect to the continuing assessment of structural integrity should be based on supporting evidence, including test and service data. This supporting evidence should include consideration of the operating loading spectra, structural loading distributions, and material behavior. An appropriate allowance should be made for the scatter in life to crack initiation and rate of crack propagation in establishing the inspection threshold, inspection frequency, and, where appropriate, retirement life. Alternatively, an inspection threshold may be based solely on a statistical assessment of fleet experience, provided that it can be shown that equal confidence can be placed in such an approach.

d. An effective method of evaluating the structural condition of older airplanes is selective inspection with intensive use of nondestructive techniques and the inspection of individual airplanes, involving partial or complete dismantling ("tear-down") of available structure.

e. The effect of *repairs, alterations and modifications approved by the TCH and made to aircraft structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure, should be considered.* ~~major repairs, alterations and modifications approved by the TCH should be considered.~~ In addition, it will be necessary to consider the effect of all *repairs and operator or STC-approved alterations and modifications on individual airplanes, which are made to aircraft structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure.* ~~major repairs and operator-approved alterations and modifications on individual airplanes.~~ The operator has the responsibility for ensuring notification and consideration of any such aspects.

2. DAMAGE-TOLERANT STRUCTURES.

a. The damage tolerance assessment of the airplane structure should be based on the best information available. The assessment should include a review of analysis, test data, operational experience, and any special inspections related to the type design. A determination should then be made of the site or sites within each structural part or component considered likely to crack, and the time or number of flights at which this might occur.

b. The growth characteristics of damage and interactive effects on adjacent parts in promoting more rapid or extensive damage should be determined. This study should include those sites that may be subject to the possibility of crack initiation due to fatigue, corrosion, stress corrosion, disbonding, accidental damage, or manufacturing defects in those areas shown to be vulnerable by service experience or design judgment.

c. The minimum size of damage that it is practical to detect and the proposed method of inspection should be determined. This determination should take into account the number of flights required for the crack to grow from detectable to the allowable limit, such that the structure has a residual strength corresponding to the conditions stated under § 25.571.

> **NOTE: In determining the proposed method of inspection, consideration should be given to visual inspection, nondestructive testing, and analysis of data from built-in load and defect monitoring devices.**

d. The continuing assessment of structural integrity may involve more extensive damage than might have been considered in the original fail-safe evaluation of the airplane, such as:

(1) A number of small adjacent cracks, each of which may be less than the typically detectable length, developing suddenly into a long crack;

(2) Failures or partial failures in other locations following an initial failure due to redistribution of loading causing a more rapid spread of fatigue; and

(3) Concurrent failure or partial failure of multiple load path elements (e.g., lugs, planks, or crack arrest features) working at similar stress levels.

3. INFORMATION TO BE INCLUDED IN THE ASSESSMENT.

a. The continuing assessment of structural integrity for the particular airplane type should be based on the principles outlined in paragraph 2 of this appendix. The following information should be included in the assessment and kept by the manufacturer in a form available for reference:

(1) The current operational statistics of the fleet in terms of hours or flights:

(2) The typical operational mission, or missions assumed in the assessment;

(3) The structural loading conditions from the chosen missions; and

(4) Supporting test evidence and relevant service experience.

b. In addition to the information specified in paragraph 3a, the following should be included for each critical part or component:

(1) The basis employed for evaluating the damage tolerance characteristics of the part or component;

(2) The site or sites within the part or component where damage could affect the structural integrity of the airplane;

(3) The recommended inspection methods for the area;

(4) For damage tolerant structures, the maximum damage size at which the residual strength capability can be demonstrated and the critical design loading case for the latter; and

(5) For damage tolerant structures, at each damage site the inspection threshold and the damage growth interval between detectable and critical, including any likely interaction effects from other damage sites.

Note: If an inspection procedure is not reliable or practicable, then replacement or modification of the structure may need to be defined.

4. INSPECTION PROGRAM. The purpose of a continuing airworthiness assessment in its most basic terms is to adjust the current maintenance inspection program, as required, to assure continued safety of the airplane type.

a. In accordance with paragraphs 1 and 2 of this appendix, an allowable limit of the size of damage should be determined for each site such that the structure has a residual strength for the load conditions specified in § 25.571, as defined in paragraph 2c. The size of damage that it is practical to detect by the proposed method of inspection should be determined, along with the number of flights required for the crack to grow from detectable to the allowable limit.

b. The recommended inspection program should be determined from the data described in paragraph a above, giving due consideration to the following:

(1) Fleet experience, including all of the scheduled maintenance checks;

(2) Confidence in the proposed inspection technique; and

(3) The joint probability of reaching the load levels described above and the final size of damage in those instances where probabilistic methods can be used with acceptable confidence.

c. Inspection thresholds for supplemental inspections should be established. These inspections would be supplemental to the normal inspections, including the detailed internal inspections.

(1) For structure with reported cracking, the threshold for inspection should be determined by analysis of the service data and available test data for each individual case.

(2) For structure with no reported cracking, it may be acceptable, provided sufficient fleet experience is available, to determine the inspection threshold on the basis of analysis of existing fleet data alone. This threshold should be set such as to include the inspection of a sufficient number of high-time airplanes to develop added confidence in the integrity of the structure (see paragraph 1c of this appendix). Thereafter, if no cracks are found, the inspection threshold may be increased progressively by successive inspection intervals until cracks are found. In the latter event, the criteria of paragraph (1) above would apply.

5. THE SUPPLEMENTAL STRUCTURAL INSPECTION DOCUMENT.

a. The Supplemental Structural Inspection Document (SSID) should contain the recommendations for the inspection procedures and replacement or modification of parts or components necessary for the continued safe operation of the airplane. The document should be prefaced by the following information:

(1) Identification of the variants of the basic airplane type to which the document relates;

(2) A summary of the operational statistics of the fleet in terms of hours and flights, as well as a description of the typical mission, or missions;

(3) Reference to documents giving any existing inspections or modifications of parts or components;

(4) The types of operations for which the inspection program is considered valid; and

(5) A list of service bulletins (or other service information publication) revised as a result of the structural reassessment undertaken to develop the SSID, including a statement that the operator must account for these service bulletins.

b. The document should contain at least the following information for each critical part or component:

(1) A description of the part or component and any relevant adjacent structure, including means of access to the part;

(2) The type of damage which is being considered (i.e., fatigue, corrosion, accidental damage);

(3) Relevant service experience;

(4) Likely site(s) of damage;

(5) Recommended inspection method and procedure and alternatives;

(6) Minimum-size of damage considered detectable by the method(s) of inspection;

(7) Service bulletins (or other service information publication) revised or issued as a result of in-service findings resulting from implementation of the SSID (added as revision to the initial SSID);

(8) Guidance to the operator on which inspection findings should be reported to the manufacturer;

(9) Recommended initial inspection threshold;

(10) Recommended repeat inspection interval;

(11) Reference to any optional modification or replacement of part or component as terminating action to inspection; and

(12) Information related to any variations found necessary to “safe lives” already declared.

c. The SSID should be checked from time to time against current service experience. Any unexpected defect occurring should be assessed as part of the continuing assessment of structural integrity to determine the need for revision of the document. Future structural service bulletins should state their effect on the SSID.

6. STRUCTURAL REPAIRS, ALTERATIONS AND MODIFICATIONS

a. Operators are responsible for ensuring that an assessment is made of all ***repairs, alterations and modifications (e.g. STCs) to aircraft structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure,*** ~~major repairs, alterations and modifications (e.g., STCs) to baseline structure~~ to develop a damage tolerance based inspection program that ensures the same confidence as the baseline structure. The baseline structure is defined as that airplane structure that was originally built by the TCH. The operator will need to conduct an assessment on each of their airplanes to determine what repairs, alterations and modifications are applicable for a damage tolerance assessment.

b. Reliance on the operator's baseline maintenance program may be critical elements of the TCH evaluation to develop the SSID. ***Repairs, alterations and modifications made to aircraft structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure,*** ~~Major repairs, alterations and modifications~~ may invalidate these maintenance programs and would require additional analysis and/or testing.

c. Operators must accomplish a damage tolerance assessment for all new repairs, alterations and modifications to ***aircraft structure that is susceptible to fatigue cracking that could contribute to a catastrophic failure.*** ~~baseline structure.~~

APPENDIX 2

GUIDELINES FOR THE DEVELOPMENT OF A PROGRAM TO PREDICT AND ELIMINATE WIDESPREAD FATIGUE DAMAGE

1. GENERAL.

a. The likelihood of the occurrence of fatigue damage in an airplane's structure increases with the number of repeated load cycles the airplane experiences. During the design process the manufacturer selects a design service goal (DSG) in terms of flight cycles/hours for the airframe. The manufacturer designs the airplane to keep the probability of cracking to a minimum up to the design service goal. It is expected that any cracking that occurs during this period will occur in isolation, originating from a single source, such as a random manufacturing flaw (e.g., a misdrilled fastener hole). Because the manufacturing flaws are randomly distributed throughout the structure, it is considered unlikely that they will result in cracks that will interact strongly as they grow.

b. Uniformly loaded structure may develop cracks in adjacent fasteners, or in adjacent similar structural details, which interact to reduce the damage tolerance of the structure in a manner which may not be readily detectable. Widespread fatigue damage (WFD) is characterized by the simultaneous presence of cracks at multiple structural details that are of sufficient size and density whereby the structure will no longer meet its damage tolerance requirement, Title 14 of the Code of Federal Regulations (14 CFR) Part 25, § 25.571 (e.g., not maintaining required residual strength after partial structural failure). Multiple Site Damage (MSD) is a source of WFD characterized by the simultaneous presence of fatigue cracks in the same structural element (e.g., fatigue cracks that may coalesce with or without other damage leading to the loss of the residual strength). Multiple Element Damage (MED) is a source of WFD characterized by the simultaneous presence of fatigue cracks in similar adjacent structural elements. The development of cracks at multiple locations (both MED and MSD) may result in strong interactions that can affect subsequent crack growth, in which case the predictions for local cracking would no longer apply. An example of this situation may occur at a fuselage skin lap joint. Simultaneous cracking at many fasteners along a common rivet line may reduce the residual strength of the joint below required levels before the cracks are readily detectable during routine maintenance

c. The methods used to date to develop structural inspection programs have generally considered only localized interactions between fatigue cracks. Since a few cracks of a size which may not be reliably detected by Non Destructive Testing (NDT) can cause unacceptable reduction in the structural strength below the residual strength requirements of the damage tolerance regulations, no widespread fatigue damage should be allowed within the original or extended design service goal of an airplane. Unless there is a high confidence in the ability to detect and rectify WFD in its early subcritical stages, continued safe operation of the airplane is jeopardized; therefore, it is necessary to take appropriate action in the aging fleets to preclude it. The manufacturers should conduct evaluations to determine where and when WFD may occur and provide instructions for the verification and removal of WFD in the airplane structure.

d. The occurrence of corrosion, or other structural degradation, can couple with fatigue cracking and reduce the effectiveness of an airplane's routine structural maintenance program.

2. STRUCTURAL EVALUATION FOR WFD.

a. General. The evaluation has three objectives:

(1) Identify primary structure susceptible to WFD (see paragraphs 2b(1) and 2b(2) of this appendix).

(2) Predict when it is likely to occur (see paragraph 2c of this appendix).

(3) Establish additional maintenance actions, as necessary, to ensure continued safe operation of the airplane (see paragraph 2d of this appendix).

b. Structure Susceptible to WFD. Susceptible structure is defined as that which has the potential to develop WFD. Such structure typically has the characteristics of similar details operating at similar stresses where structural capability could be affected by interaction of similar cracking. The generic types of susceptible structure include the following:

(1) Fuselage.

(a) Longitudinal skin joints, frames, and tear straps (MSD, MED);

(b) Circumferential joints and stringers (MSD, MED);

(c) Fuselage frames (MED);

(d) Aft pressure dome outer ring and dome web splices (MSD, MED);

(e) Other pressure bulkhead attachment to skin and web attachment to stiffener and pressure decks (MSD, MED);

(f) Stringer to frame attachments (MED);

(g) Window surround structure (MSD, MED);

(h) Over-wing fuselage attachments (MED);

(i) Latches and hinges of nonplug doors (MSD, MED);

(j) Skin at runout of large doubler (MSD).

(2) Wing and Empennage.

(a) Skin at runout of large doubler (MSD);

(b) Chordwise splices (MSD, MED);

(c) Rib to skin attachments (MSD, MED);

(d) Stringer runout (MED, MSD).

c. Determination of WFD. The time in terms of hours and/or flights to the occurrence of WFD should be established. The evaluation should include a complete review of the service history of the susceptible areas, relevant full-scale and component fatigue test data, teardown inspections, and any fractographic analysis available. The evaluation of test results for the reliable prediction of the time WFD occurs in each susceptible area should include appropriate test-to-structure factors and a scatter factor.

(1) Each susceptible area should be evaluated to establish the size and extent of multiple cracking that could cause the residual strength to degrade below certification levels.

(2) Each susceptible area should be evaluated for a discrete source damage event due to uncontained failure of engines, fan blades, and high-energy rotating machinery.

(3) Each susceptible area should be evaluated to establish the time WFD is expected to occur.

(a) This initial estimate may be analytically determined, supported by existing test or service evidence.

(b) Revised estimates of the time of WFD occurrence should be made based on additional information from the continuing assessment of the fleet-demonstrated capability and one or more of the following:

1 Additional fatigue and/or residual strength tests on a full-scale airplane structure or a full-scale component, followed by detailed inspections and analyses.

2 Testing of new or used structure on a smaller scale than full component tests (i.e., sub-component and/or panel tests).

3 Tear-down inspections (destructive) that could be done on structural components that have been removed from service.

4 Local teardown by selected, limited (non-destructive) disassembly and refurbishment of specific areas of high-time airplanes.

d. Maintenance Actions.

(1) For all areas that have been identified as susceptible to WFD, the current maintenance program should be evaluated to determine if adequate structural maintenance and inspection programs exist to safeguard the structure against unanticipated cracking or other structural degradation. The evaluation of these inspections should typically be done as follows:

(a) Determine the level (inspection threshold, repeat interval, and methods) of the inspection for each susceptible area that is necessary to maintain the required level of safety.

(b) Review the existing maintenance programs to determine if they provide the required level of safety.

(2) For airplanes approaching the estimated occurrence of WFD, a program should be developed and recommended to the FAA that provides for replacement or modification of the susceptible structural area.

e. Period of Evaluation Validity. The initial evaluation of the complete airframe should cover a significant forward projection of airplane usage beyond the design service goal. Typically an assessment through at least an additional twenty-five percent of the design service goal would provide a realistic forecast with reasonable planning time for necessary maintenance action. However, it may be appropriate to vary the evaluation validity period depending on issues such as:

(1) The projected useful life of the airplane at the time of the initial evaluation (could increase or decrease the validity period).

(2) Expectations of improved Non Destructive Inspection (NDI) technology (could decrease the initial validity period, pending new methods becoming available).

(3) Airline advance planning requirements for introduction of new maintenance and modification programs.

(4) Providing sufficient forward projection to identify all likely maintenance/modification actions essentially as one package.

Subsequent evaluations should follow similar validity period guidelines as the initial evaluation.

3. DOCUMENTATION.

a. The manufacturers should revise the SID as necessary and/or prepare Service Bulletins that contain the recommendations for inspection procedures and replacement or modification of parts or components necessary to preclude WFD. Since WFD is applicable to all operators and is a safety concern for older airplanes, identified inspection or modification programs will be made mandatory. In addition, any service bulletins or other service information publications revised or issued as a result of in-service WFD findings resulting from implementation of these programs may require separate AD action.

b. If the manufacturer chooses not to update the SID or prepare Service Bulletins, it should develop a WFD document containing recommendations for inspection procedures and replacement or modification of parts or components necessary to preclude WFD. The document should be prefaced by the following:

(1) Identification of the variants of the basic airplane type to which the document relates;

(2) Summary of the operational statistics of the fleet in terms of hours and flights;

(3) Description of the typical mission, or missions;

(4) The types of operations for which the inspection program is considered valid;

(5) Reference to documents giving any existing inspections, or modification of parts or components; and

(6) Duration of evaluation validity.

c. The document should contain at least the following information for each critical part or component:

(1) Description of the primary structure susceptible to WFD

(2) The estimated threshold of MSD/MED and subsequent occurrence (hours/cycles) of WFD;

(3) Recommended initial inspection threshold;

(4) Recommended repeat inspection interval;

(5) Recommended inspection method and procedure and alternatives;

(6) Any optional modification or replacement of the structural element as terminating action to inspection;

(7) Any mandatory modification or replacement of the structural element;

(8) Service bulletins (or other service information publication) revised or issued as a result of in-service findings resulting from the WFD evaluations (added as a revision to the initial WFD document); and

(9) Guidance to the operator on which inspection findings should be reported to the manufacturer.

4. RESPONSIBILITY. It is expected that the evaluation will be conducted in a cooperative effort between the operators and manufacturers with participation by airworthiness authorities during the evaluation.

Appendix D: ARAC Recommendations on WFD

The following Draft NPRM was submitted to ARAC on May 23, 2001, and represents the AAWG recommendations for rulemaking on the subject of WFD.

[4910-13-U]

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Parts 91, 121, 125, 129 and 135

[Docket No. ______________; Notice No. ____________]

RIN: 2120-

Aging Aircraft Program (Widespread Fatigue Damage)

AGENCY: *Federal Aviation Administration (FAA), DOT.*

ACTION: *Notice of proposed rulemaking.*

SUMMARY: *The FAA proposes to require incorporation of a program to preclude widespread fatigue damage (WFD) into the FAA-approved maintenance or inspection program of each operator of large transport category airplanes. This action is the result of concern for the continued operational safety of airplanes that are approaching or have exceeded their design service goal. This proposed rulemaking would require a limit of validity (in flight cycles or hours) of the structural maintenance program, where additional inspections and/or modification/replacement actions must be incorporated into the operator's maintenance or inspection programs in order to allow continued operation.*

DATES: *Send your comments on or before [Insert date 90 days after date of publication in the Federal Register.]*

ADDRESSES: *Address your comments to the Docket Management System, U.S. Department of Transportation, Room Plaza 401, 400 Seventh Street, SW., Washington, DC 20590-0001. You must identify the docket number ____________ at the beginning of your comments, and you should submit two copies of your comments. If you wish to receive confirmation that FAA received your comments, include a self-addressed, stamped postcard.*

You may also submit comments through the Internet to http://dms.dot.gov. You may review the public docket containing comments to these proposed regulations in person in the Dockets Office between 9:00 a.m. and 5:00 p.m., Monday through Friday, except Federal holidays. The Dockets Office is on the plaza level of the NASSIF Building at the Department of Transportation at the above address. Also, you may review public dockets on the Internet at http://dms.dot.gov.

FOR FURTHER INFORMATION CONTACT: *Brent Bandley, FAA, Transport Airplane Directorate, Los Angeles Aircraft Certification Office, ANM-120L, 3960 Paramount Boulevard, Lakewood, California 90712-4137; telephone (562) 627-5237, fax (562) 627-5210.*

SUPPLEMENTARY INFORMATION:

Comments Invited

Interested persons are invited to participate in the making of the proposed action by submitting such written data, views, or arguments as they may desire. Comments relating to the environmental, energy, federalism, or economic impact that might result from adopting the proposals in this document also are invited. Substantive comments should be accompanied by cost estimates. Comments must identify the regulatory docket or notice number and be submitted in duplicate to the DOT Rules Docket address specified above.

All comments received, as well as a report summarizing each substantive public contact with FAA personnel concerning this proposed rulemaking, will be filed in the docket. The docket is available for public inspection before and after the comment closing date.

All comments received on or before the closing date will be considered by the Administrator before taking action on this proposed rulemaking. Comments filed late will be considered as far as possible without incurring expense or delay. The proposals in this document may be changed in light of the comments received.

Commenters wishing the FAA to acknowledge receipt of their comments submitted in response to this document must include a pre-addressed, stamped postcard with those comments on which the following statement is made: "Comments to Docket No. ______________." The postcard will be date-stamped and mailed to the commenter.

Availability of NPRM

You can get an electronic copy using the Internet by taking the following steps:

(1) Go to the search function of the Department of Transportation's electronic Docket Management System (DMS) web page (http://dms.dot.gov/search).

(2) On the search page type in the last four digits of the Docket number shown at the beginning of this notice. Click on "search."

(3) On the next page, which contains the Docket summary information for the Docket you selected, click on the document number of the item you wish to view.

You can also get an electronic copy using the Internet through the Office of Rulemaking's web page at http://www.faa.gov/avr/armhome.htm or the Federal Register's web page at http://www.access.gpo.gov/su_docs/aces/aces140.html.

You can also get a copy by submitting a request to the Federal Aviation Administration, Office of Rulemaking, ARM-1, 800 Independence Avenue SW, Washington, DC 20591, or by calling (202) 267-9680. Make sure to identify the docket number, notice number, or amendment number of this rulemaking.

BACKGROUND

List of Acronyms Used in this Document

For the reader's reference and ease of reading, the following list defines the acronyms that are used throughout this document:

ACRONYM	***DEFINITION***
AAWG	*Airworthiness Assurance Working Group*
ACO	*Aircraft Certification Office*
AD	*Airworthiness Directive*
ALS	*Airworthiness Limitations Section*
AMM	*Airplane Maintenance Manuals*
ARAC	*Aviation Rulemaking Advisory Committee*
ART	*Authority Review Team*
CPCP	*Corrosion Prevention and Control Program*

DER	*Designated Engineering Representative*
DSD	*Discrete source damage*
DSG	*Design service goal*
ESG	*Extended service goal*
FAA	*Federal Aviation Administration*
ICA	*Instructions for Continued Airworthiness*
ISP	*Inspection start point*
JAA	*Joint Airworthiness Authorities*
LOV	*Limit of Validity*
MED	*Multiple element damage*
MRB	*Maintenance Review Board*
MSD	*Multiple site damage*
MSG	*Maintenance Steering Group*
NDI	*Non-destructive inspection*
NTSB	*National Transportation Safety Board*
PMI	*Principal Maintenance Inspector*
PSE	*Principal structural element*
RAP	*Repairs Assessment Program*
SSID	*Structural Supplemental Inspection Document*
SMP	*Structural modification point*
SSIP	*Supplemental Structural Inspection Program*
STC	*Supplemental Type Certificate*
STG	*Structural Task Group*
TAD	*Transport Airplane Directorate*
TC	*Type certificate*
TCH	*Type certificate holder*
TOGAA	*Technical Oversight Group re: Aging Aircraft*
WFD	*Widespread fatigue damage*

Events Leading to Proposed Rule

In April 1988, a high-cycle transport airplane enrooted from Hilo to Honolulu, Hawaii, suffered major structural damage to its pressurized fuselage during flight. The airplane managed to land after a structural failure caused the separation of an 18-foot section of upper fuselage. The National

Transportation Safety Board (NTSB) determined that widespread fatigue damage (WFD) was a contributing cause of this accident.

Widespread fatigue damage is characterized by simultaneous presence of cracks at multiple structural details that are of sufficient size and density such that the structure will no longer meet its damage-tolerance requirement and could catastrophically fail. Uniformly loaded structure may develop cracks in adjacent fasteners, or in adjacent similar structural details. These cracks can interact to reduce the damage tolerance of the structure in a manner that may not be readily detectable. Sources of WFD include:

- *Multiple site damage (MSD) is a source of WFD characterized by the simultaneous presence of fatigue cracks in the same element (i.e., fatigue cracks that may coalesce with or without other damage, leading to a loss of required residual strength).*
- *Multiple element damage (MED) is a source of WFD characterized by the simultaneous presence of fatigue cracks in similar adjacent structural elements.*

Regulatory and industry experts agree that, as the transport airplane fleet continues to age, eventually WFD is inevitable. Long-term reliance on existing maintenance programs, even those that incorporate the latest mandatory changes introduced to combat aging, creates an unacceptable risk of age-related accidents. Even with the existing aging aircraft program for large transports in place, WFD can and does occur in the fleet. Therefore, the FAA has determined that, at a certain point of an airplane's life, the existing aging aircraft program is not sufficient to ensure the continued airworthiness of that fleet of airplanes.

Since the 1988 accident in Hawaii, the FAA has identified several cases of WFD occurring in the fleet of large transport airplanes, although there has not been a catastrophic accident directly attributable to WFD. Some examples are:

- *In-flight failure of aft pressure bulkhead stringer attach fittings on the Lockheed Model L-1011;*
- *Aft pressure bulkhead cracks found on the McDonnell Douglas Model DC-9;*
- *Lap splice cracking found in the Boeing Models 727 and 737; and*
- *Frame cracking found in the Boeing Model 747.*

The FAA, the European Joint Airworthiness Authorities (JAA), and representatives of the Airworthiness Assurance Working Group (AAWG), working under the auspices of the Aviation Rulemaking Advisory Committee (ARAC), have reviewed available service difficulty reports for the transport airplane fleet. They also have evaluated the certification and design practices applied to these previously certificated airplanes, including fatigue test results. The review revealed that all airplanes in the fleet are susceptible to some sort of MSD or MED. Based on this review, many areas were identified as those most susceptible to MSD or MED, for example:

AREA	***SUSCEPTIBLE TO:***
Longitudinal skin joints, frames, and tear straps	*MSD/MED*
Circumferential joints and stringers	*MSD/MED*
Fuselage Frames	*MED*
Lap joints with milled, chem-milled, or bonded radius	*MSD*
Stringer-to-frame attachments	*MED*

Shear clip end fasteners on shear tied fuselage frames	*MSD/MED*
Aft pressure dome outer ring and dome web splices	*MSD/MED*
Skin splice at aft pressure bulkhead	*MSD*
Abrupt changes in web or skin thickness — pressurized or unpressurized structure	*MSD/MED*
Window surround structure	*MSD/MED*
Overwing fuselage attachments	*MED*
Latches and hinges of non-plug doors	*MSD/MED*
Skin at runout of large doubler (MSD)—fuselage, wing or empennage	*MSD*
Rib to skin attachments	*MSD/MED*
Typical Wing/Empennage Structure	*MSD/MED*
Wing and empennage chordwise splices	*MSD/MED*

__NOTE__: The FAA has developed a proposed Advisory Circular (AC) 91-56B, "Continuing Structural Integrity Program for Large Transport Category Airplanes," which contains illustrations of the areas susceptible to MSD and/or MED. The availability of that proposed AC is announced elsewhere in this Federal Register.

The FAA has been addressing these safety issues on a case-by-case basis by issuing airworthiness directives (AD) requiring corrective action. The ADs address the immediate problem, but they do not address potential WFD problems that may exist on other components of the aircraft in question, and they are not a proactive means to deal with aging aircraft overall. They also frequently impose added costs on operators because of the necessity of implementing corrective action outside of normal maintenance schedules, and they consume significant regulatory resources on a continuing basis.

ARAC Recommendations Concerning WFD

In 1993, ARAC made seven recommendations to the FAA concerning the need for a structural audit of transport category airplanes to determine the state of WFD in the transport fleet. These recommendations were:

- *The AAWG should promote a WFD evaluation of each airplane model within the existing Structures Task Group (STG) environment, using the guidance of AC 91-56, "Supplemental Structural Inspection Program for Large Transport Category Airplanes" (as modified to include the material mentioned in Recommendation 2, below). These evaluations should be conducted in the timeliest possible fashion relative to the airplane model age.*
- *AC 91-56 should be modified to include guidelines for conducting a structural WFD evaluation.*
- *The STGs should recommend appropriate fleet actions, through the Supplemental Structural Inspection Program (SSIP) or service bulletin modification programs.*
- *The AAWG should be responsible for monitoring evaluation progress and results for consistency of approach for all models.*
- *Mandatory action should enforce STG recommendations by normal FAA means.*

- *Additional rulemaking is not necessary or desirable for timely achievement of the evaluation safety goals for the 11 airplane models originally evaluated by the AAWG.*
- *Additional actions for the airplanes currently in production should only be considered after completion of the initial evaluations of the 11 airplane models originally evaluated by the AAWG.*

The basic recommendation was to amend FAA's AC 91-56 to include guidance for a proposed structural audit for WFD. Furthermore, the report advocated that the audit would be performed voluntarily by the STGs under the direction of the manufacturers. Any safety-related issues would be brought to the attention of the FAA for corrective action.

The AAWG developed a new appendix to AC 91-56 that provides guidance on the development of a WFD prediction and verification technique to preclude operation of large transport airplanes in the presence of WFD. ARAC submitted this guidance to the FAA as a recommendation, and the FAA accepted it. In April 1998, the FAA issued AC 91-56A, "Continuing Structural Integrity Program for Large Transport Category Airplanes." That AC contains Appendix 2, entitled "Guidelines for the Development of a Program to Predict and Eliminate Widespread Fatigue Damage," which is based on the ARAC/AAWG recommendations.

On August 28, 1997 (62 FR 45690), the FAA tasked ARAC again with determining the extent of WFD in the fleet. To obtain the pertinent data, ARAC was to review analytical methods, relevant fatigue test data, related research work, and teardown inspection reports. The review was to take into account the AAWG report "Structural Fatigue Evaluation for Aging Aircraft," dated October 14, 1993.

The FAA also tasked ARAC develop time standards for implementation of a WFD program and to recommend courses of action the FAA might take to address this issue. ARAC assigned this task to the AAWG.

The tasking required that a team of technical experts review the technical program that was developed by the AAWG. The purpose of this review was to validate the approach adopted by the AAWG and to ensure compliance with the tasking. The Authority Review Team (ART) consisted of representatives from the United Kingdom Civil Aviation Authority (UK-CAA), French Direction Générale de l'Aviation Civile (DGAC), and the FAA. The ART conducted its initial review in March 1998, and again in January 1999. It supported the report, with three caveats that have since been resolved.

The AAWG/ARAC completed the tasking and produced a final report entitled "Recommendations for Regulatory Action to Prevent Widespread Fatigue Damage in the Commercial Fleet," Revision A, dated June 29, 1999 (hereafter identified as the "WFD Report"). The ARAC submitted the report to the FAA and the FAA accepted the recommendations. [A copy of this report is included in the public docket for this rulemaking].

The list of five items below summarizes a number of recommendations in the WFD Report developed by the FAA, JAA, and AAWG to improve the current structural maintenance program to preclude WFD from the fleet.

1. *Clarify the terminology in AC 91-56A.*

2. *Because of the instances of MSD/MED in the fleet and the continued reliance on surveillance types of inspections to discover such damage, develop rules and advisory material that will provide specific programs, including a structural audit, to preclude WFD in the fleet.*

3. *Implement an effective aging airplane program, including a Mandatory Modifications Program, Corrosion Prevention and Control Program (CPCP), Repair Assessment Program (RAP), and a Supplemental Structural Inspection Program (SSIP) or Airworthiness Limitations Section (ALS) as a necessary prerequisite for effective program to address MSD/MED.*

4. *Use a monitoring period for the management of potential MSD/MED scenarios in the fleet, if the structural audit determines that MSD/MED cracking is detectable before the structure loses its required residual strength.*

5. Carefully consider any program established to correct MSD or MED in the fleet to ensure that the necessary lead times to develop resources to implement fleet action are addressed. For example, operators need time to assess their fleet and accomplish a structural audit of repaired, altered or modified structure that is susceptible to MSD or MED.

The FAA tasked the Technical Oversight Group re: Aging Aircraft (TOGAA) to review and comment on the WFD Report. TOGAA endorsed the AAWG methodology on January 10, 2000.

In December 1999, a new task was assigned to ARAC entitled "Task 6: Aging Aircraft Program (Widespread Fatigue Damage - WFD)." In the tasking, the FAA requested that ARAC develop recommendations for operating rules and a revision to § 25.1529, Appendix H, to implement an aging aircraft program that would include a program to preclude WFD from the fleet. ARAC assigned this task to the AAWG. This proposed rule and proposed AC 91-56B (discussed later) are based on the recommendations submitted by ARAC to the FAA in response to this tasking.

Related Regulatory Activity

In addition to the initiatives previously discussed, there are other on-going activities that are associated with FAA's Aging Aircraft Program. These include FAA's response to the Aging Aircraft Safety Act, and future rulemaking to mandate corrosion prevention and control programs for all airplanes used in air transportation.

By the Aging Aircraft Safety Act of 1991 (Public Law 49 U.S.C. 44717), Congress instructed the Administrator to prescribe regulations that ensure the continuing airworthiness of aging aircraft through inspections and reviews of the maintenance records of each aircraft an air carrier uses in air transportation.

Proposed Aging Airplane Safety Final Rule

In response to the Act, the FAA published Notice of Proposed Rulemaking (NPRM) 99-02 on April 2, 1999 (64 FR 16298), entitled "Aging Airplane Safety." The proposed rule would ensure the continued airworthiness of aging airplanes operating in air transportation by applying damage tolerance analysis and inspection techniques through mandatory records reviews and inspections after the airplane's fourteenth year in service. Damage tolerance-based supplemental inspections would be applicable to the baseline structure [as built by the Type Certificate Holder (TCH)] and all major repairs, alterations, and modifications. The damage tolerance-based supplemental inspections would be required 4 years after the effective date of the proposed rule (with certain exceptions for airplanes with mandated AC 91-60 service-based supplemental inspection programs or for airplanes whose design life goal has been listed in the tables provided in the proposed rule).

That proposed rule would be applicable to:

- *all airplanes operated under 14 CFR part 121,*
- *all U.S. registered multi-engine airplanes operated under 14 CFR part 129, and*
- *all multi-engine airplanes operated in scheduled operations under 14 CFR part 135.*

The FAA has reviewed the public comments to that Notice and anticipates regulatory action in the near future based on those comments and other considerations.

Proposed Corrosion Prevention and Control Program Rule

In addition, the FAA has found that some operators do not have a programmatic approach to corrosion prevention and control programs (CPCP). In its accident investigation report (NTSB/AAR-89/03) on the 1988 accident in Hawaii, the NTSB recommended that the FAA mandate a comprehensive and systematic CPCP. Therefore, the FAA is considering rulemaking to mandate CPCPs for all airplanes used in air transportation. More details about this proposed rule are described later in this preamble.

Existing Regulations and Certification Methods

The current 14 CFR part 25 regulations that are intended to require designs to preclude WFD from the fleet are as follows:

Section 25.571(b) requires that special consideration for WFD must be included where the design is such that this type of damage could occur. Also, it must be demonstrated with sufficient full-scale fatigue test evidence that WFD will not occur within the design service goal of the airplane. These requirements were added to § 25.571 at Amendment 25-96 in 1998 (63 FR 23338, April 28, 1998). Therefore, these requirements have only been applied on the most recent type certification projects.

Prior to Amendment 25-96, § 25.571 and its predecessor CAR 4b did not fully address WFD. Prior to Amendment 25-45 (43 FR 46242, October 5, 1978), § 25.571 and CAR 4b-270 required that those parts of the structure whose failure could result in catastrophic failure of the airplane must be evaluated by a fatigue or fail safe analysis, tests, or both. At Amendment 25-45, § 25.571 was changed to require that those parts of the structure whose failure could result in catastrophic failure be evaluated by a damage tolerance assessment.

In general, for large transport category airplanes certified prior to amendment 25-96, the TCHs have conducted full-scale fatigue tests, even though they were not required. In some cases, by additional fatigue testing, teardown, and analysis, the DSG has been changed to an extended service goal (ESG).

Airplane Maintenance Manuals and Instructions for Continued Airworthiness

Historically, TCHs have been required to provide maintenance-related information for structures. Prior to 1970, most TCHs provided manuals containing maintenance information for large transport category airplanes, but there were no standards prescribing minimum content, distribution, and a timeframe in which the information must be made available to the operator. Section 25.1529, which was added to part 25 by amendment 25-21 in February 1970, required the applicant for a type certificate to provide airplane maintenance manuals (AMM) to owners of the airplanes. This section was later amended by amendment 25-54 (45 FR 60173, September 11, 1980) to require that the applicant for type certification provide Instructions for Continued Airworthiness (ICA) prepared in accordance with Appendix H to part 25. In developing the ICA, the applicant is required to include certain information such as a description of the airplane and its systems, servicing information, and maintenance instructions, including the frequency and extent of the structural inspections necessary to provide for the continued airworthiness of the airplane. As required by Appendix H to part 25, the ICA must also include an FAA-approved Airworthiness Limitations section (ALS) enumerating those mandatory inspections, inspection intervals, replacement times, and related procedures approved under § 25.571, relating to structural damage tolerance.

One method of establishing initial scheduled maintenance and inspection tasks is the Maintenance Steering Group (MSG) process, which develops a Maintenance Review Board (MRB) document for a particular airplane model. The resultant of the MSG-3 process is an MRB document that contains inspections of the aircraft to address accidental damage, environmental damage, and fatigue damage. Operators may incorporate those provisions, along with other maintenance information contained in the ICA, into their maintenance or inspection program. Earlier MSG processes were used that may not fully address this issue.

Section 21.50 requires the holder of a design approval [including the TC or supplemental type certificate (STC) for an airplane, aircraft engine, or propeller for which application was made after January 28, 1981] to furnish at least one set of the complete ICA to the owner of the product for which the application was made. The ICA for original type certificated products must include inspection and replacement instructions for the structures. A design approval holder who has modified the structure must furnish a complete set of ICA for the modification to the owner of the product.

Type Certificate Amendments Based on Major Change in Type Design

Over the years, many design changes have been introduced into the structure that may affect their safety. There are three ways that design changes can be approved:

1. The TCH can apply for an amendment to the type design.

2. Any person, including the TCH, wanting to alter a product by introducing a major change in the type design not great enough to require a new application for a TC, may apply for an STC.

3. In some instances, a person also may make a major alteration or repair to the type design through a field approval. The field approval process is a streamlined method for obtaining approval of relatively simple modifications to airplanes. An FAA Flight Standards Inspector can approve a repair or alteration using FAA Form 337.

Maintenance and Inspection Program Requirements

Airplane operators are required to have extensive maintenance or inspection programs that include provisions relating to structure:

Section 91.409(e), which generally applies to other than commercial operations, requires an operator of a large turbojet multi-engine airplane or a turbopropeller-powered multi-engined airplane to select one of the following four inspection programs:

1. An inspection program that is part of a continuous airworthiness maintenance program currently in use by a person holding an air carrier operating certificate, or an operating certificate issued under part 119 for operations under parts 121 or 135, and operating that make and model of airplane under those parts;

2. An approved airplane inspection program approved under § 135.419 and currently in use by a person holding an operating certificate and operations specifications issued under part 119 for part 135 operators;

3. A current inspection program recommended by the type certificate holder; or

4. Any other inspection program established by the registered owner or operator of that airplane and approved by the Administrator.

Section 121.367, which is applicable to those air carrier and commercial operations covered by part 121, requires operators to have an inspection program, as well as a program covering other maintenance, preventative maintenance, and alterations.

Section 125.247, which is generally applicable to operation of large airplanes, other than air carrier operations conducted under part 121, requires operators to inspect their airplanes in accordance with an inspection program approved by the Administrator.

Section 129.14 requires a foreign air carrier and each foreign operator of a U.S. registered airplane in common carriage, within or outside the U.S., to maintain the airplane in accordance with an FAA-approved program.

In general, to develop the overall maintenance or inspection program for their airplanes, operators rely on:

- The Type Certificate (TC) data sheet,
- MRB reports,
- ICA,
- The ALS of the ICA,
- Other manufacturer's recommendations, and
- Their own operating experience.

They also have maintenance programs related to aging aircraft, such as the following four programs or their equivalents:

1. Supplemental Structural Inspection Programs (SSIP): The SSIPs were traditionally mandated by airworthiness directives for certain large transport category airplanes (Airbus Model A300; British Aerospace BAC 1-11; Boeing Models B-707/720, B-727, B-737, B-747; McDonnell Douglas Models DC-8, DC-9/MD-80, DC-10; Fokker F28; and Lockheed Model L-1011 series airplanes) and numerous other transport category airplanes. The TCHs for these airplanes developed the Supplemental Structural

Inspection Document (SSID), which was mandated by AD. These mandated inspection programs supplemented each operator's maintenance program.

The FAA is considering additional rulemaking (see section above on "Related Rulemaking Activity") to require that maintenance or inspection programs of the following airplanes include an FAA-approved SSIP:

- *All airplanes operated under part 121,*
- *All U.S. registered multi-engine airplanes operated in common carriage by foreign air carriers or foreign persons under part 129, and*
- *All multi-engine airplanes used in scheduled operations operated under part 135.*

The airplanes subject to the requirement for a SSIP were not certified to a damage tolerance requirement. However, the structure to be evaluated, the type of damage considered (fatigue, corrosion, service, and production damage), and the inspection and/or modification criteria should, to the extent practicable, be in accordance with the damage-tolerance principles of the current § 25.571 standards. An acceptable means of compliance can be found in AC 25.571-1C or the latest revision that recommends the consideration of the following elements.

It is essential to identify the structural parts and components that contribute significantly to carrying flight, ground, pressure, or control loads, and whose failure could affect the structural integrity necessary for the continued safe operation of the airplane. The damage tolerance or safe-life characteristics of these parts and components must be established or confirmed.

Analyses made in respect to the continuing assessment of structural integrity should be based on supporting evidence, including test and service data. This supporting evidence should include consideration of the operating loading spectra, structural loading distributions, and material behavior. An appropriate allowance should be made for the scatter in life to crack initiation and rate of crack propagation in establishing the inspection threshold, inspection frequency, and, where appropriate, retirement life. Alternatively, an inspection threshold may be based solely on a statistical assessment of fleet experience, provided that it can be shown that equal confidence can be placed in such an approach.

An effective method of evaluating the structural condition of older airplanes is selective inspection with intensive use of nondestructive techniques and the inspection of individual airplanes, involving partial or complete dismantling ("tear-down") of available structure.

The effect of major repairs, alterations, and modifications approved by the TCH should be considered. In addition, it will be necessary to consider the effect of all major repairs and operator-approved alterations and modifications on individual airplanes. The operator has the responsibility for ensuring notification and consideration of any such aspects.

2. <u>Corrosion Prevention and Control Programs (CPCP)</u>: The CPCPs were mandated by airworthiness directives (AD) for certain large transport category airplanes (Airbus Model A300; British Aerospace BAC 1-11; Boeing Models B-707/720, B-727, B-737, B-747; McDonnell Douglas Models DC-8, DC-9/MD-80, DC-10; Fokker F28; and Lockheed Model L-1011 series airplanes) and numerous other transport category airplanes. The TCHs for these airplanes developed the CPCP document that was mandated by AD. These CPCPs supplemented each operator's maintenance program.

The corrosion programs were developed based on the premise that operators would adjust them when unacceptable corrosion levels were found. These maintenance program adjustments should preclude recurrence of unacceptable corrosion findings. Adjustments may include actions such as reduced repetitive task intervals, improved corrosion treatments, or multiple corrosion inhibitor applications.

The FAA is considering additional rulemaking to require that maintenance or inspection programs for the following types of airplanes include an FAA approved CPCP:

- *All airplanes operated under part 121,*

- *All U.S. registered multi-engine airplanes operated in common carriage by foreign air carriers or foreign persons under part 129, and*
- *All multi-engine airplanes used in scheduled operations operated under part 135.*

That proposed rule would give operators two years to incorporate a CPCP into their maintenance or inspection program. (That rulemaking will be issued in response to the Aging Airplane Safety Act of 1991.)

3. Repair Assessment Program: The industry was tasked to develop a method for airlines to evaluate airplane repairs to determine whether they are acceptable permanent repairs incorporating damage tolerance. This program will ensure that existing and future repairs to the fuselage pressure boundary are assessed for damage tolerance.

On April 19, 2000, the FAA issued a final rule entitled "Repair Assessment for Pressurized Fuselages," which promulgated four new operating rules:

- *§ 91.410 (Amdt. 91-264);*
- *§ 121.370 (Amdt. 121-275),*
- *§ 125.248 (Amdt. 125-33), and*
- *§ 129.32 (Amdt. 129-28).*

That final rule was published in the Federal Register on April 15, 2000 (65 FR 24108). Additionally, corrections to the final rule were published on June 5, 2000 (65 FR 35703), and August 21, 2000 (65 FR 50744). The final rule's effective date was May 25, 2000. That rule prohibits the operation of certain large transport category airplanes (Airbus Model A300; British Aerospace BAC 1-11; Boeing Models B-707/720, B-727, B-737, B-747; McDonnell Douglas Models DC-8, DC-9/MD-80, DC-10; Fokker F28; and Lockheed Model L-1011 series airplanes) operated under parts 91, 121, 125, and 129 beyond a specified compliance time, unless the operator of those airplanes had incorporated FAA-approved repair assessment guidelines applicable to the fuselage pressure boundary (fuselage skin, door skin, and bulkhead webs) in its operation specification(s) or approved inspection program, as applicable. That rule ensures that a comprehensive damage tolerance repair assessment be completed for repairs to the fuselage pressure boundary.

The FAA also issued an associated advisory circular: AC 120-73, "Damage Tolerance Assessment of Repairs to Pressurized Fuselages," dated December 14, 2000. That AC provides an acceptable means of compliance with the regulations that require incorporating FAA-approved repair assessment guidelines into an operator's FAA-approved maintenance or inspection program.

4. Mandatory Modifications Program: The mandatory modification program was based on the premise that, to ensure the structural integrity of older airplanes, there should be less reliance on repetitive inspections when certain criteria exist. These criteria included:

- *There is a high probability that structural cracking exists.*
- *There is a potential airworthiness concern.*
- *The cracks are difficult to detect during regular maintenance. (Considerations under this criterion are: the areas to inspect are difficult to access; NDT methods are unsuitable; and human factors associate with the inspection technique are so adverse that crack detection may not be sufficiently dependable to assure safety.)*
- *There is adjacent structural damage or the potential for it.*

The FAA issued airworthiness directives that incorporated the structural modification program on the original eleven models (Airbus Model A300; British Aerospace BAC 1-11; Boeing Models B-707/720, B-727, B-737, B-747; McDonnell Douglas Models DC-8, DC-9/MD-80, DC-10; Fokker F28; and Lockheed Model L-1011 series airplanes). Each of the TCHs, with their respective operators, reviewed their service bulletins with the FAA to determine which areas of structure needed modifications to terminate the *inspections. Then the revised service bulletins that included those terminating modifications were either grouped in a document and mandated, or each service bulletin was mandated individually.*

These four programs or their equivalent make up the current structural maintenance program that operators incorporate into their maintenance or inspection programs to address aging structural issues. However, additional maintenance actions are necessary to address WFD issues Specific maintenance instructions to detect and correct conditions that degrade the structural capabilities due to WFD were not previously deemed necessary because it was assumed that the current structural maintenance and inspection programs would be enough to protect the structure.

Also, the validity of the current structural maintenance program is not limited to a number of flight cycles or flight hours. Certain structural components may be limited and must be replaced at a certain number of flight cycles or flight hours; but if the operator accomplishes the maintenance or inspection program as outlined, they can operate the airplanes indefinitely.

DISCUSSION OF THE PROPOSAL

FAA's review of the service history, design features, and maintenance instructions of the transport fleet indicates that aging of structures susceptible to MSD and MED, which could eventually lead to WFD, has become a safety issue for the fleet of transport category airplanes greater than 75,000 pounds (maximum takeoff gross weight).

The FAA proposes to amend the current regulations in two areas to prevent WFD.

1. The first requirement concerns the need to limit the validity of the current structural maintenance program.

2. The second requirement concerns the need to impose operational requirements that mandate a structural maintenance program to prevent WFD in the fleet on baseline, repaired, altered, and modified structure. For the purposes of this proposed rule, baseline structure is defined as "the structure that was originally designed and built by the TCH."

These proposed operational rules would apply only to large transport airplanes greater than 75,000 pounds (maximum takeoff gross weight). The FAA recognizes that this does not align with the "One Level of Safety" initiative (i.e., the same safety level for large airplanes as well as commuter/small airplanes). However, there are two reasons for not including the commuter and smaller airplanes in this rulemaking at this time:

First, in addressing the Aging Aircraft Safety Act of 1991, there already has been considerable rulemaking activity to establish mandated SSIP, CPCP, structural modifications, and repair assessment programs for all aircraft operated under part 121, all U.S.-registered multi-engine aircraft operated under part 129, and all multi-engine aircraft used in scheduled operations under part 135. The TCHs and operators of large transport airplanes have been involved with mandated CPCP and damage tolerance-based SSIPs for many years now and are positioned to address the advanced technical issues of how to handle WFD.

Second, several of the initiatives of the Aging Aircraft Safety Act of 1991 are being accomplished to bring commuter aircraft in line with aging aircraft programs that have already been accomplished on the large transports for several years now. However, the Aging Commuter Aircraft Program is not yet as mature as the Large Transport Aging Aircraft Program. In many cases, commuter aircraft TCHs are developing CPCPs and damage tolerance-based SSIPs for the first time. Further, many of these commuter aircraft were originally certified to safe-life and fail-safe rules, so the aircraft TCHs are not familiar with analyzing airplanes using damage tolerance principles. The FAA has funded development of damage tolerance-based SSIPs to help foster this development process for the smaller aircraft. Damage tolerance-based SSIP final rules for the commuter airplanes are not scheduled to be mandated until [redacted] The CPCP final rule may not be issued until FY 2002.

Proposed Operating Requirements

In each operational rule part, the proposed rule would impose two new operating rules. These are described below:

Operational Rule 1 – Basis of Structural Maintenance Program

The first operating rule, entitled "Basis of Structural Maintenance Program," would prohibit the operation of transport category airplanes greater than 75,000 pounds (maximum takeoff gross weight) unless the ALS of the ICA that includes the flight cycle or flight hour limits of validity of the structural maintenance program is incorporated in its maintenance or inspection program within 12 months after the effective date of the proposed rule. Regardless of the certification basis, the initial limit of validity chosen must ensure that WFD is precluded from the fleet up until the limit has been reached by that airplane.

Currently, only airplanes certified to the damage-tolerance requirements of § 25.571 at or after amendment 25-54 have an ALS incorporated into their ICA. This proposed rule would make that a requirement for all affected transport category airplanes greater than 75,000 lbs. (maximum takeoff gross weight).

Acceptable elements of the current aging aircraft program would be included or referenced in the ALS of the ICA. The following is a summary of the current aging aircraft structural maintenance program:

1. *Acceptable mandatory modifications programs are those programs that have reviewed all relevant service bulletins and have produced a document that lists those service bulletins with applicable terminating modifications that has been mandated by an airworthiness directive. Not all of the terminating modifications are in a single document. There may be airworthiness directives that mandate terminating modifications for individual service bulletins.*

2. *An acceptable CPCP includes those CPCP documents that were mandated by airworthiness directives. The CPCP mandated by airworthiness directives should be referenced in the ALS of the ICA. Also, for airplanes certified to the damage tolerance requirements at or after amendment 25-54, and for those operators that have incorporated a maintenance program in accordance with MSG-3, Revision 2, and an acceptable CPCP is found in the MRB document for those items listed under environmental damage (ED). (As indicated previously, the FAA is considering additional rulemaking to require that maintenance or inspection programs for transport category airplanes include an FAA approved CPCP.)*

3. *An acceptable SSIP includes those SSIDs developed in accordance with AC 91-56 that are mandated by ADs. Those mandated SSIDs would be referenced in the ALS of the ICA. Also, an acceptable SSIP would be the ALS of the ICA itself, for those airplanes certified to the damage tolerance requirements at or after Amendment 25-54. Also the "Aging Airplane Safety" rule will require damage tolerance-based SSIPs be required 4 years after the effective date of the proposed rule.*

4. *An acceptable RAP for the fuselage pressure boundary is found for the 11 original "aging models" listed in §§ 91.410, 121.370, 125.248, and 129.32. Airplanes certified to the damage tolerance requirements at or after Amendment 25-45 should have acceptable repair assessment programs. As part of their certification basis, operators should be assessing repairs for damage tolerance. The Aging Airplane Safety Final Rule will require some operators to develop damage tolerance based supplemental inspections for all major repairs, alterations and modifications to baseline structure within 4 years after the effective date of the rule.*

With these aging aircraft structural maintenance programs in place, the TCH will need to establish a limit to the current structural maintenance program in flight cycles or flight hours for a particular airplane model. The limit of validity chosen must ensure that WFD is precluded from the fleet up until the limit has been reached by that airplane, at which time the airplane stops operating or continues to operate based on a maintenance program designed to preclude the occurrence of WFD in the fleet. The FAA expects that, typically, the TCH will choose to limit the airplane at the DSG. The DSG was usually established by the TCH as a period of time (in flight cycles/hours), established at design or certification, during which the principal structure will be reasonably free from significant cracking. Most of the TCHs performed fatigue tests on their airplane models to twice the life delineated in the DSG. Some of the TCHs did additional fatigue testing, teardown, in-service evaluations and analysis to establish an ESG.

When the DSG/ESG were originally conceived, the industry believed that airplanes would be retired before reaching these goals. In some cases, however, airplanes have been operated well beyond the DSG. Therefore, it is imperative to limit the validity of the current structural maintenance program until *the maintenance program addresses inspections and/or modification/replacement of structure to prevent WFD in the fleet.*

As a result of the AAWG activities, the TCHs have agreed to develop or revise, for each affected airplane model, the ALS of the ICA to reference the applicable aging aircraft programs delineated above and to establish a limit of validity to the current structural maintenance program (in flight cycles/hours). (A copy of these ALS documents is included in the public docket for this rulemaking.) The TCH should ensure that the limits of validity chosen would ensure that the probability of WFD in the fleet is very low. The FAA will entertain any other entities (e.g. operators) that would like to establish the limit of validity for a particular model based on their knowledge of the model and its susceptibility to WFD. Once the FAA is satisfied the limits of validity chosen are appropriate, the ALS will receive a "conditional" approval by the FAA ACO or office of the Transport Aircraft Directorate (TAD) having cognizance over the type certificate before publication of this NPRM.

Operational Rule 2 – Aging Aircraft Program

The second operating rule, entitled "Aging Aircraft Program (Widespread Fatigue Damage)," would require a three-part compliance:

First, for baseline structure, this proposed rule would prohibit the operation of certain transport category airplanes greater than 75,000 pounds (maximum takeoff gross weight) beyond the flight cycle limits shown in its ALS of the ICA, or 12 months after the effective date of the proposed rule, whichever occurs later, unless a structural maintenance program is incorporated within its maintenance or inspection program. This new program must include inspections and/or modification/replacement actions to the baseline structure for prevention of WFD. The baseline structure is defined as that airplane structure that was originally built by the TCH.

The new structural maintenance program will be limited by flight cycles or flight hours, which must be specified in the ALS that has been approved by the FAA ACO or office of the TAD, having cognizance over the type certificate for the affected airplane. Any subsequent revisions to the structural maintenance program for WFD must also be approved by the FAA ACO of office of the TAD having cognizance over the type certificate for the affected airplane before they can be incorporated within the operator's maintenance or inspection program.

For the baseline structure, most of the major TCHs have agreed to publish the inspection procedures and modification/replacement as necessary to preclude WFD in the fleet for those airplanes that have exceeded their DSG or ESG by December 31, 2001 and will require "conditional" approval by the FAA ACO or office of the TAD having cognizance over the type certificate. (A copy of that documentation for airplanes that have exceeded their DSG/ESG has been provided in the public docket for this rulemaking action). The operator could choose to incorporate that program to meet the proposed requirement.

If the TCH chooses not to develop inspection procedures and modification/replacement as necessary to preclude WFD in the fleet, then the operator would not be able to operate the airplane beyond the limit of validity established in the ALS of the ICA. The operator would also have the option of developing its own program independently to address WFD in its fleet, and ultimately would be responsible for gaining FAA approval.

Second, for structure with existing repairs or alterations, this proposed rule also would prohibit operation of certain transport category airplanes greater than 75,000 pounds (maximum takeoff gross weight), 48 months after initial incorporation of the structural maintenance program for the baseline structure or 48 months beyond the time that the airplane has accumulated the flight cycles shown in the limit of validity manifested in its ALS of the ICA, whichever occurs later, unless a structural maintenance program is incorporated within its maintenance or inspection program. This new program must include inspections and/or modifications/replacement actions for repairs, alterations, or modifications susceptible to MSD/MED or repairs, alterations or modifications that affect baseline structure that is susceptible to MSD/MED accomplished prior to the effective date of this proposed rule for the prevention of WFD. . The new structural maintenance program must be approved by the FAA ACO or office of the TAD, having *cognizance over the type certificate for the affected airplane. The proposed rule would specify that certain tasks would need to be accomplished within the noted 48-month time frame, including:*

- *Within six months, operators establish a plan to address repairs, alterations and modifications, which include identification of interim inspections of applicable repairs, alterations, and modifications. Each operator submits that plan to the FAA ACO or office of the TAD through the operator's PMI.*
- *Within six months after receipt of the plan, the FAA ACO or office of the TAD approves the plan if it is acceptable.*
- *Within six months after receipt of the FAA approved plan, each operator incorporates interim inspections of applicable repairs, alterations, and modifications identified in the plan.*
- *Within 36 months after initial incorporation per paragraph (a) or within 36 months beyond the time that the airplane has accumulated the flight cycles or flight hours shown in the limit of validity manifested in its ALS of the ICA, whichever occurs later, each operator submits the structural maintenance program to the FAA ACO or office of the TAD through the operator's PMI.*
- *Within six months after receipt of the structural maintenance program, the FAA ACO or office of the TAD approves the program if it is acceptable.*
- *Within 48 months after initial incorporation per paragraph (a) or within 48 months beyond the time that the airplane has accumulated the flight cycles or flight hours shown in the limit of validity manifested in its ALS of the ICA, whichever occurs later, each operator incorporates the FAA approved program into its maintenance program.*

Third, for new repairs and alterations (installed after effective date of this NPRM), the proposed rule also would prohibit operation of certain transport category airplanes, greater than 75,000 pounds (maximum takeoff gross weight), 18 months after a repair, alteration or modification susceptible to MSD or MED or a repair, alteration or modification that affects baseline structure that is susceptible to MSD or MED is accomplished on or after the effective date of the rule, unless an appropriate threshold for inspection and/or replacement is incorporated within its maintenance program. This new program must include a threshold where inspections and modification/replacement actions to said repair, alteration, or modification must be incorporated to preclude WFD. The new structural maintenance program must be approved by the FAA ACO or office of the TAD, having cognizance over the type certificate for the affected airplane. The following requirements are to be accomplished at the times noted below:

- *The static strength approval of the repair, alteration, or modification is to be accomplished before further flight.*
- *Within 18 months of the static strength approval, a damage-tolerance analysis that includes a WFD analysis of the repair, alteration or modification is approved by the FAA ACO or office of the TAD, which defines the threshold for inspections and/or modification/replacement actions is included in the operators FAA approved structural maintenance program.*
- *Within 24 months before reaching the threshold, specific FAA approved inspection methods and repeat intervals are incorporated for each repair, alteration or modification into the FAA approved structural maintenance program.*

The intent of the rule is to require operators first to incorporate a program to preclude WFD in the fleet for baseline structure. Then, the operators would be required to develop a plan, and eventually a structural maintenance program, to preclude WFD in the fleet for repaired, altered, or modified structure. The plan would be developed by the operators and must be based on a survey of their fleet to identify MSD/MED susceptible areas that should be inspected in the interim while the structural maintenance program is being developed. The plan would be sent to the FAA ACO or office of the TAD, having cognizance over the type certificate through the operator's PMI and, if acceptable, would approve the plan with a letter signed by the Manager of the ACO or office of the TAD, as appropriate.

Once the plan is approved, the operator would need to begin inspecting areas of the structure susceptible to MSD/MED. Also, the operator would be required to conduct a WFD assessment of the repaired, altered, or modified structure. The analysis to support the WFD assessment and any new inspections or modification/replacement schedules would need to be FAA-approved.

Once the WFD assessment is completed, the operator would be required to develop a structural maintenance program and submit it to the FAA ACO or office of the TAD through the PMI for approval. Once the approval is obtained, the operator would incorporate the structural maintenance program into its maintenance or inspection program.

The structural maintenance program provided by the manufacturer does not generally apply to structure modified by repairs, alterations, or modifications (e.g., modification installed via an STC). However, under this proposed rule, the operator would still be responsible to conduct a survey of its fleet and provide a WFD assessment of fatigue critical structure that meets the program objectives of precluding WFD in the operator's fleet.

The FAA recognizes that operators do not usually have the resources to determine an inspection and/or modification/replacement schedule. The FAA expects the STC holder to assist the operators in preparing the required documents. If the STC holder is out of business, or is otherwise unable to provide assistance, the operator will have to accomplish WFD assessment independently. To keep the airplanes in service, it is possible for operators, individually or as a group, to hire the necessary expertise to develop and gain approval of WFD assessments and the associated an inspection and/or modification/replacement schedule. Ultimately, the operator remains responsible for the continued safe operation of the airplane.

The cost and difficulty of developing WFD assessments for repaired, altered, or modified structure may be less than that for the basic airplane structure for various reasons. Of those repairs, alterations, or modifications that do affect the structure, many are small enough that the structure may not be susceptible to MSD/MED (i.e., an antenna installation with a small hole in the middle of two frame bays.) Also, the modification may have been made so recently that no supplemental inspections would be needed for many years. For example, in the case of a large cargo door, such installations are often made after the airplane has reached the end of its useful life as a passenger-carrying airplane. For new structure, the clock would start on WFD assessment at the time of installation. Further, since the inspection start point is measured in cycles, and cargo operation usually entails fewer operational cycles than passenger operations, the due date for incorporation of the non-destructive inspection (NDI) and procedures for that structure could be many years away.

To assist operators and STC holders, the TCH maintenance program documents will contain general guidelines developed along strict boundaries for the screening of repairs, alterations, and STCs.

The operator, normally in conjunction with the TCH, would need to consider the following three things:

1. The means by which the FAA-approved structural maintenance program that addresses WFD are incorporated into a certificate holder's FAA-approved maintenance or inspection program, as would be required by the proposed rule, is subject to approval by the certificate holder's PMI or other cognizant airworthiness inspector.

2. This rule would not impose any new reporting requirements; however, normal reporting required under §§ 121.703 and 125.409 would still apply.

3. This rule would not impose any new FAA recordkeeping requirements. However, as with all maintenance, the current operating regulations (e.g., 14 CFR §§ 121.380 and 91.417) already impose recordkeeping requirements that would apply to the actions required by this proposed rule. When incorporating the structural maintenance program that addresses WFD into its approved maintenance or inspection program, each operator should address the means by which it will comply with these recordkeeping requirements. That means of compliance, along with the remainder of the program, would be subject to approval by the cognizant PMI or other cognizant airworthiness inspector.

In summary, based on discussions with representatives of the affected industry, recommendations from ARAC, and a review of current rules and regulations affecting WFD, the FAA has determined there is a need for a structural maintenance program, including inspections and modification/replacement actions, for the prevention of WFD to be incorporated into the maintenance or inspection program for certain transport category airplanes.

Possible Airworthiness Directives

For airplanes certified to § 25.571, pre-Amendment 25-54, this proposed rule would create a new ALS of the ICA. The proposed rule would set a limit of validity (in flight cycles or hours) in the ALS of the ICA of the current structural maintenance program for each applicable model. If no program to preclude WFD in the fleet is incorporated by the operator in their maintenance or inspection program, then the operator could not operate the airplane beyond the established flight cycle or flight hour limit.

If the TCH conducts a structural evaluation of the baseline structure for WFD and develops a program to preclude WFD in the fleet, then the TCH would develop a new limit (in flight cycles or flight hours) to the structural maintenance program beyond which the airplane could not be operated. The new limit should be referenced in a revision to the ALS of the ICA and submitted to the FAA for approval. The Administrator would approve the new revision to the ALS of the ICA with a letter of approval. If the new limit is less than the original limit established by the TCH, then the Administrator will need to mandate that limit referenced in the revise ALS of the ICA with an AD.

During the time that the TCH is conducting a structural evaluation for WFD of baseline structure, or the operator is conducting a structural evaluation for WFD of repaired, altered, or modified structure, an unsafe condition may be identified that must be rectified by immediate inspections and/or modification/replacement of structure. If this occurs, the FAA will mandate those actions by issuing an appropriate AD.

Structural Evaluation for WFD

The likelihood of the occurrence of fatigue damage in an airplane's structure increases with airplane usage. The design process generally establishes a DSG in terms of flight cycles/hours for the airframe. It is expected that any cracking that occurs on an airplane operated up to the DSG will occur in isolation (i.e., local cracking), originating from a single source, such as a random manufacturing flaw (e.g., a mis-drilled fastener hole) or a localized design detail. It is considered unlikely that cracks from manufacturing flaws or localized design issues will interact strongly as they grow.

With extended usage, uniformly loaded structure may develop cracks in adjacent fastener holes, or in adjacent similar structural details. These cracks, while they may or may not interact, can have an adverse affect on the large damage capability (LDC) before the cracks become detectable. The development of cracks at multiple locations (both MSD and MED) also can result in strong interactions that can affect subsequent crack growth, in which case the predictions for local cracking would no longer apply. An example of this situation may occur at any skin joint where load transfer occurs. Simultaneous cracking at many fasteners along a common rivet line may reduce the residual strength of the joint below required levels before the cracks are detectable under the routine maintenance program established at time of certification.

The operator, normally in conjunction with the TCH, is expected to initiate the development of a maintenance program with the intent of precluding operation with WFD. Such a program must be implemented before WFD may develop in the fleet as substantiated by analysis, tests, and/or service experience. Because of the small probability of occurrence of MSD/MED in airplane operation up to its DSG, maintenance programs developed for initial certification have generally considered only local fatigue cracking. Therefore, as the airplane reaches its DSG, it is necessary to take appropriate action in the aging fleets to preclude WFD so that continued safe operation of the airplane is not jeopardized. The TCH and /or the operator(s) should conduct structural evaluations to determine where and when MSD/MED may occur. Based on these evaluations the TCH and in some cases the operators would provide additional maintenance instructions for the structure as appropriate. The maintenance instructions include, but are not limited to:

- *Inspections,*
- *Structural modifications, and*
- *Limits of validity of the new maintenance instructions.*

In most cases, a combination of inspections and/or modifications/replacements is deemed necessary to achieve the required safety level. Other cases will require modification or replacement if inspections are not viable.

Before MSD/MED can be addressed, it is expected that the operators will incorporate an augmented structural maintenance program that includes the Mandatory Modifications Program, CPCP, SSIP and RAP to address structural degradation such as corrosion, accidental damage and fatigue.

The structural evaluation for WFD has three objectives:

1. *Identify primary structure susceptible to MSD/MED.*
2. *Predict when it is likely to occur.*
3. *Establish additional maintenance actions, as necessary, to ensure continued safe operation of the airplane.*

Structure Susceptible to MSD/MED

Susceptible structure is defined as that which has the potential to develop MSD/MED. Such structure typically has the characteristics of multiple similar details operating at similar stresses where structural capability could be affected by interaction of multiple cracking at a number of similar details. There are a number of generic types of structure that have demonstrated the development of MSD/MED in service. These structural details are illustrated in proposed AC 91-56B, Appendix 2, Section 3(b). (NOTE: The illustrations contained in proposed AC 91-56B are by no means exhaustive and are included to stimulate the review of all possible structure.)

WFD Evaluation

By the time the high time airplane of a particular model reaches its DSG, the evaluation for each area susceptible to the development of WFD should be completed. This evaluation will establish the necessary elements to determine a maintenance program to preclude WFD in that particular model's commercial airplane fleet. These elements are developed for each susceptible area and include:

- *Determination of WFD Average Behavior in the Fleet.*
- *Initial Crack/Damage Scenario.*
- *Final Cracking Scenario.*
- *Crack Growth Calculation.*
- *Potential for Discrete Source Damage (DSD).*
- *Analysis Methodology Issues.*
- *Inspection Start Point (ISP).*
- *Structural Modification Point (SMP).*
- *Inspection Interval and Method.*

(One means of developing these elements is discussed in detail in proposed AC 91-56B, Appendix 2.)

Evaluation of Maintenance Actions

For all areas that have been identified as susceptible to MSD/MED, the current maintenance program should be evaluated to determine if adequate structural maintenance and inspection programs *exist to safeguard the structure against unanticipated cracking or other structural degradation. The evaluation of the current maintenance program typically begins with the determination of the SMP for each area.*

Each area should then be reviewed to determine the current maintenance actions that are directed against the structure and compare them to the maintenance requirements.

- *Determine the inspection requirements (method, reliability, inspection start point, and repeat interval) of the inspection for each susceptible area (including that structure that is expected to arrest cracks) that is necessary to maintain the required level of safety.*
- *Review the elements of the existing maintenance programs already in place*
- *Revise and highlight elements of maintenance program necessary to maintain safety.*

For susceptible areas approaching the SMP, where the SMP will not be increased, or for areas that cannot be reliably inspected, a program should be developed, and documented that provides for replacement or modification of the susceptible structural area.

Period of Evaluation Validity

The initial evaluation of the complete airframe should cover a significant forward estimation of the projected airplane usage beyond its DSG, also known as the "Proposed ESG." Typically, an assessment through at least an additional twenty-five percent of the DSG would provide a realistic forecast with reasonable planning time for necessary maintenance action.

Upon completion of the evaluation and publication of the revised maintenance requirements, the Proposed ESG becomes the ESG. Subsequent evaluations should follow similar validity period guidelines as the initial evaluation.

Documentation

Any person developing a program to comply with the proposed rule must develop a document containing recommendations for inspection procedures and replacement or modification of parts or components necessary to preclude WFD, and establish the new limit of validity of the operator's maintenance program. That person also must revise the SSID or ALS, as necessary, and/or prepare service bulletins that contain the recommendations for inspection procedures and replacement or modification of parts or components necessary to preclude WFD.

The new limit of validity of the ALS of the ICA and the program documents containing inspection procedures and replacement actions must be submitted to the FAA ACO or office of the TAD cognizant over the type certificate. If acceptable, the FAA ACO or office of the TAD will approve the new limit of validity of the ALS of the ICA by letter signed by the Manager of the FAA ACO or office of the TAD, as appropriate.

In addition, any service bulletins or other service information publications revised or issued as a result of in-service MSD/MED findings resulting from implementation of these programs may require separate AD action.

(NOTE: Details of the documentation required by the FAA are contained in proposed AC 91-56B, Appendix 2.)

Reporting Requirements

Operators and TCHs are required to report failures, malfunctions, defects, mechanical reliability, etc. in accordance with various regulations (e.g., § 121.703, § 21.3, etc.). While these reporting requirements would not be modified for this proposed rule, both the operators and the TCHs should be cognizant of the following issues concerning reporting:

Due to the potential threat to structural integrity, the results of inspections must be accurately documented and reported in a timely manner to preclude the occurrence of WFD. The current system of operator-manufacturer communication has been useful in identifying and resolving a number of issues that can be classified as WFD concerns. MSD/MED has been discovered via fatigue testing and in-

service experience. Airplane TCHs have been consistent in disseminating related data to operators to solicit additional service experience. However, a more thorough means of surveillance and reporting is essential to preclude WFD.

When damage is found while conducting a FAA-approved MSD/MED inspection program or at SMP where replacement or modification of the structure is occurring, the TCHs, STC Holder and the operators need to ensure that greater emphasis is placed on accurately reporting the following items:

- A description (with a sketch) of the damage, including crack length, orientation, location, flight cycles/hours and condition of structure.
- Results of follow-up inspections by operators that identify similar problems on other airplanes in the fleet.
- Findings where inspections accomplished during the repair or replacement/modification identify additional similar damage sites.
- Adjacent repairs within the same PSE.

Operators should report all cases of MSD/MED to the TCH, STC Holder, or the FAA as appropriate, irrespective of how frequently such cases occur. Cracked areas from in-service airplanes (damaged structure) may be needed for detailed examination. Operators are encouraged to provide fractographic specimens whenever possible. Airplanes undergoing heavy maintenance checks are perhaps the most useful sources for such specimens.

Operators should remain diligent in the reporting of potential MSD/MED concerns not identified by the TCH. Indications of a developing MSD/MED problem may include:

- Damage at multiple locations in similar adjacent details;
- Repetitive part replacement; or
- Adjacent repairs with similar types of damage.

Documentation will be provided by the TCH, STC Holder as appropriate to specify the required reporting format and time frame. The data will be reviewed by the TCH/STC Holder, operator(s), and regulatory authority to evaluate the nature and magnitude of the problem and to determine the appropriate corrective action.

Structural Modifications, Repairs, and Alterations

Operators are responsible for ensuring that all major modifications (STCs), repairs, and alterations that create, modify, or affect structure that has been identified by the TCH as susceptible to MSD/MED are evaluated to demonstrate the same confidence level as the original manufactured structure (i.e., a "two life-time fatigue test"). The operator will need to conduct a survey on each of its airplanes to determine what modifications, repairs, or alterations would be susceptible to MSD/MED. The following are examples of modifications, repairs, and alterations with such concerns:

- Passenger-to-freighter conversions (including addition of main deck cargo doors);
- Gross weight increases (increased operating weights, increased zero fuel weights, increased landing weights and increased maximum takeoff weights);
- Installation of fuselage cutouts (passenger entry doors, emergency exit doors or crew escape hatches, fuselage access doors and cabin window relocations);
- Complete re-engine and/or pylon modifications;
- Engine hush-kits and nacelle alterations;
- Wing modifications such as the installation of winglets or changes in flight control settings (flap droop), and alteration of wing trailing edge structure;
- Modified, repaired, or replaced skin splices; and

- *Any modification, repair, or alteration that affects several stringer or frame bays.*

Other potential areas that must be considered include:

- *A modification that covers structure requiring periodic inspection by the operator's maintenance program. Modifications must be reviewed to account for the differences with the TCHs baseline maintenance program requirements.*
- *A modification that results in operational mission change that significantly changes the manufacture's load/stress spectrum. An example of this would be a passenger-to-freighter conversion.*
- *A modification that changes areas of the fuselage from being externally inspect able using visual means to being unimpeachable. An example would be the installation of a large external fuselage doubler that results in hiding details beneath it, rendering them visually uninspectable.*

Aging Aircraft Program Implementation Time

The applicability of this WFD structural evaluation has been expanded from the eleven aging fleet models initially evaluated by the AAWG. (The AAWG evaluation is contained in the AAWG's report, "Structural Fatigue Evaluation for Aging Aircraft," dated October 14, 1993. That report has been made a part of the public docket for this proposed rulemaking action.) This proposed rule would apply to all large transport category airplanes having a maximum takeoff gross weight (MTOGW) greater than 75,000 pounds, which have been certified to either a pre- or post- amendment 25-45 certification basis.

In order to ensure that the WFD evaluation is completed in a timely manner, with respect to the actual service life accumulated, the FAA has established the following fleet selection criteria, based on the DSG or the ESG:

1. <u>Airplane cycle age is greater than the DSG or ESG on the effective date of the final rule</u>. The operator would be required to incorporate an aging aircraft program including inspections and modifications/replacement actions for prevention of WFD in its maintenance or inspection program by the flight cycle limits shown in its ALS of the ICA, or one year after the effective date of the rule, whichever occurs later. It is conceivable that the operator will need to replace or modify baseline structure on airplanes that have operated beyond the SMP noted in the program documents (inspections and replacement/modification actions) that address WFD for that structure. The operator should begin planning as soon as possible for this eventuality to ensure that the necessary maintenance is performed with as little disruption of fleet utilization as possible. The operator also should be making a survey of all those repairs, alterations, and modifications that are susceptible to MSD/MED, and producing a plan for FAA approval.

2. <u>Airplane cycle age is greater than 75% DSG or ESG, but less than DSG or ESG on the effective date of the final rule</u>. The WFD structural audit program development should have begun by this time. Operators should be making a survey of all those repairs, alterations, and modifications that are susceptible to MSD/MED, and initiating a plan for FAA approval.

3. <u>Airplane cycle age is greater than 50% DSG or ESG, but less than 75% DSG or ESG on the effective date of the final rule</u>. The WFD structural audit program should be in the preliminary planning stages by this time. The operator should be planning to perform a survey of all those repairs, alterations, and modifications that are susceptible to MSD/MED.

FAA Advisory Material

In addition to the amendments proposed in this notice, the FAA has proposed to revise AC 91-56A to AC 91-56B, "Continuing Structural Integrity Program for Large Transport Category Airplanes." The proposed revised AC would provide guidance for operators of the affected transport category airplanes on how to incorporate an FAA-approved "Aging Aircraft Program" into their FAA-approved maintenance or inspection program. Public comments concerning the proposed AC are invited by separate notice published elsewhere in this issue of the <u>Federal Register</u>

Paperwork Reduction Act

The Paperwork Reduction Act of 1995 (44 U.S.C. 3507(d)) requires that the FAA consider the impact of paperwork and other information collection burdens imposed on the public. We have determined that there are no new information collection requirements associated with this proposed rule.

International Compatibility

In keeping with U.S. obligations under the Convention on International Civil Aviation, it is FAA policy to comply with International Civil Aviation Organization (ICAO) Standards and Recommended Practices to the maximum extent practicable. The FAA determined that there are no ICAO Standards and Recommended Practices that correspond to these proposed regulations.

Economic Evaluation, Regulatory Flexibility Determination, International Trade Impact Assessment, and Unfunded Mandates Assessment

Proposed changes to Federal regulations must undergo several economic analyses. First, Executive Order 12866 directs that each Federal agency shall propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs. Second, the Regulatory Flexibility Act of 1980 requires agencies to analyze the economic impact of regulatory changes on small entities. Third, the Trade Agreements Act (19 U.S.C. 2531-2533) prohibits agencies from setting standards that create unnecessary obstacles to the foreign commerce of the United States. In developing U.S. standards, this Trade Act also requires the consideration of international standards and, where appropriate, that they be the basis of U.S. standards. And fourth, the Unfunded Mandates Reform Act of 1995 (Pub.L. 104-4) requires agencies to prepare a written assessment of the costs, benefits, and other effects of proposed or final rules that include a Federal mandate likely to result in the expenditure by State, local, or tribal governments, in the aggregate, or by the private sector, of $100 million or more annually (adjusted for inflation).

In conducting these analyses the FAA has determined that this proposed rule: (1) has benefits that justify its costs; is "a significant regulatory action," as defined in Executive Order 12866; and is "significant," as defined in the Department of Transportation's regulatory policies and procedures (44 FR 11034, February 26, 1979); (2) would have a significant impact on a substantial number of small entities; (3) would not constitute a barrier to international trade; and (4) would not impose an unfunded mandate on State, local, or tribal governments, or the private sector. These analyses are available in the docket and are summarized below. The FAA invites the public to provide comments and supporting data on the assumptions made in this evaluation. All comments received will be considered in any final regulatory evaluation.

Benefits

Current inspection programs are unlikely to uncover WFD problems with airplanes. However, WFD has a positive probability of occurring as the number of cycles exceeds the established limit of validity of the airplanes.

Over the course of the past 17 years, there have been three or more WFD-related accidents or incidents involving sudden depressurizations or other major in-flight disruptions that have resulted in property damage and/or loss of life. Without the proposed WFD program, it is likely that this same experience would be repeated in the future. In the event of an accident, the fleet of that airplane type would be grounded until the fatigue critical structure is inspected and/or modified/replaced, with resulting losses in airline income and potential losses to consumers. In addition, in the absence of the proposed rule, airplanes are more likely to be grounded unexpectedly when MSD or MED are detected. If not addressed, MSD or MED may cause the residual strength of airplane structure to fall below the damage tolerant requirements which would result in a WFD condition.

The benefits of the proposed regulation over the planning horizon would be:

Avoided accident costs—C_{t1}

Avoided fleet groundings—C_{t2}.

The expected value of these benefits is:

$$(1) \qquad PV(B) = PV_t\,[A(L_t)\,(C_{t1} + C_{t2}) + P(C_{t2})]$$

which says in words that the present value (PV) of the avoided costs over the planning horizon (t) is the historic WFD accident rate (A) (accidents by affected fleet divided by landings by the fleet) multiplied by landings (L) in year (t) multiplied by the two costs avoided plus the probability (P) of detecting a WFD problem during normal maintenance multiplied by the costs of unexpected groundings.

The annual benefits of the WFD regulation can be separated into two groups:

1. <u>Accident-Related Benefits</u>: The accident-related benefits relate to the estimated costs of accidents that would otherwise occur in the absence of the regulation. These estimated benefits include

both the direct costs of the accident and the costs of inspecting and modifying the type of fuselages that were involved in the accident.

2. Detection-Related Benefits: The detection benefits relate to costs incurred by operators when they find WFD problems during the course of their normal maintenance operations; in such cases, the operators will need to develop an inspection and modification program for their fleet.

Both the accident related and detection related benefits are developed stochastically. The accident related benefits depend importantly upon the accident rate and the number of landings by fuselage types during each year of the analysis. Accidents are assumed to be rare events whose behavior is governed by the Poisson distribution. The present value of the mean accident-related benefits is $653.5 million. In FAA's analysis/simulation, there are on average 6.4 WFD related accidents over the 20-year analysis period. Between three and ten accidents occur in approximately 80 percent of the simulations. Zero accidents occur less than one percent of the time. The range of accident-related benefits is from 15 million to $1.5 billion in year 2000 dollars. The median value is $633.8 million, which is close to the mean.

The detection related benefits also are produced stochastically. Because WFD problems will occur as airplanes operate beyond their limit of validity, operators are likely to detect such problems over the 20-year forecast period. It has been assumed that there is a probability of finding WFD problems in each model type of five percent in each year. Under this assumption, there is a 35 percent chance that there will be zero WFD problems detected for a particular model type over a 20-year period. The detection behavior is characterized by the binomial distribution, so that in any given year there is either a WFD problem detected or there is not for each model type. Once a WFD problem is detected, it is assumed that the operators will undertake an inspection and modification program. It is assumed that this inspection program will be approximately 35 percent of the cost of the inspection program that would be undertaken under regulation. The learning curve effects are assumed to apply to these inspections and modifications. Airplanes are assumed to be out of service for a average of 13 days to undertake all of the inspections and modifications, resulting in denial of service (flight cancellations) and loss of revenue costs.

The FAA's analysis/simulation revealed the mean detection benefit estimate as $94.5 million in year 2000 dollars. This ranges from a minimum of $1.75 million to a maximum of $175 million. Eighty percent of the time the detection benefits range between $37.8 and $116.4 million in year 2000 dollars.

The benefits of this proposal consist of accident prevention and the prevention of unscheduled maintenance and groundings of fleets of aircraft. The present value total benefits of this proposal are estimated to be $728.0 million.

Costs

The costs of the WFD program include the following:

- *The regulatory costs of establishing the rule;*
- *The costs to manufacturers or other third parties of developing inspection and modification programs to satisfy the rule; it is assumed that these costs are passed forward to operators;*
- *The direct cost to operators of performing inspections and modifications/replacement actions required under the rule;*
- *The cost of early retirement of airplanes in the event that airlines find it more cost effective to retire airplanes than to inspect/modify or replace structure.*

It should be noted that the attributable costs of the regulation do not include the expense of making modifications or major repairs to structure that has been found to be cracked during inspections mandated by the rule. While these modifications or repairs may represent a significant direct expense, their costs are not attributable to the proposed rule because existing FAA regulations require that repairs be made when they are found to be necessary to ensure the continued airworthiness of the airplane. However, modifications that may be required to raise the limit of validity (LOV) for the current *maintenance program —i.e., those assumed to be required to be made for an airplane to reach 125% of LOV are properly assigned to the rule costs.*

It is assumed that the rule will become effective in the year 2004. In that year, approximately 163 airplanes would be subject to the rule. Their operators will be presented with the choice either to undertake an inspection and modification/replacement program or to retire the airplanes. In the analysis, the operators are assumed to select the lower cost alternative. So, for example, in the first year when the rule is assumed to become effective, 136 airplanes would be retired or inspected at a cost of $34.2 million. In that same year, 27 airplanes would be retired or modified at a cost of $36.1 million. (All dollar figures are in discounted year 2000 dollars.) Exposure data and cost estimates are provided for each year.

The total discounted present value costs of the inspection and structural modifications that would be required by the proposed WFD regulation are estimated to be $358.1 million.

Benefit/Cost Comparison

The $728.0 million benefits of this proposed rule exceed the estimated costs of the proposed rule of $358.1 million. Therefore, the FAA considers this proposal to be cost-justified.

Initial Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (RFA) establishes "as a principle of regulatory issuance that agencies shall endeavor, consistent with the objective of the rule and of applicable statutes, to fit regulatory and informational requirements to the scale of the business, organizations, and governmental jurisdictions subject to regulation." To achieve that principle, the RFA requires agencies to solicit and consider flexible regulatory proposals and to explain the rationale for their actions. The RFA covers a wide range of small entities, including small businesses, not-for-profit organizations and small governmental jurisdictions.

Agencies must perform a review to determine whether a proposed or final rule will have a significant economic impact on a substantial number of small entities. If the determination is that it will, the agency must prepare a regulatory flexibility analysis as described in the RFA.

However, if an agency determines that a proposed or final rule is not expected to have a significant economic impact on a substantial number of small entities, section 605(b) of the RFA provides that the head of the agency may so certify and a regulatory flexibility analysis is not required. The certification must include a statement providing the factual basis for this determination, and the reasoning should be clear.

Under the RFA, the FAA must determine whether or not a proposed rule significantly affects a substantial number of small entities. This determination is typically based on small entity size and cost thresholds that vary depending on the affected industry. The FAA has conducted the required review and determined that this proposed rule would have a significant impact on a substantial number of small entities. Accordingly, a regulatory analysis was conducted as required by the RFA, and is summarized in this section.

The FAA has analyzed the effects of this proposal on small entities. It appears that this proposal would have a significant effect on a significant number [redacted] of small entities.

Entities potentially affected by the proposed rule include:

[to be completed by APO]

The FAA has attempted to mitigate the impacts on these firms by considering alternatives, such as extending the compliance deadline for small entities. The alternatives are discussed in the full initial regulatory evaluation associated with this rule.

International Trade Impact Assessment

The Trade Agreement Act of 1979 prohibits Federal agencies from engaging in any standards or related activity that create unnecessary obstacles to the foreign commerce of the United States. Legitimate domestic objectives, such as safety, are not considered unnecessary obstacles. The statute also requires consideration of international standards and, where appropriate, that they be the basis for U.S. standards. In addition, consistent with the Administration's belief in the general superiority and desirability of free trade, it is the policy of the Administration to remove or diminish, to the extent feasible, barriers to international trade, including barriers affecting the export of American goods and services to foreign countries and barriers affecting the import of foreign goods and services into the United States.

In accordance with the above statute and policy, the FAA has assessed the potential effect of this proposed rule and has determined that it does not have an effect on international trade.

Unfunded Mandates Assessment

The Unfunded Mandates Reform Act of 1995 (2 U.S.C. 1532-1538) is intended, among other things, to curb the practice of imposing unfunded Federal mandates on State, local and tribal governments. It requires each Federal agency to prepare a written statement assessing the effects of any Federal mandate in a proposed or final agency rule that may result in a $100 million or more expenditure (adjusted annually for inflation) in any 1 year by State, local, and tribal governments, in the aggregate, or by the private sector; such a mandate is deemed to be a "significant regulatory action."

This proposed rule does not contain a Federal intergovernmental or private sector mandate that exceeds $100 million in any 1 year. Therefore, the requirements of the Unfunded Mandates Reform Act of 1995 do not apply.

Executive Order 13132, Federalism

The FAA has analyzed this proposed rule under the principles and criteria of Executive Order 13132, Federalism. We determined that this action would not have a substantial direct effect on the States, on the relationship between the national Government and the States, or on the distribution of power and responsibilities among the various levels of government. Therefore, we determined that this notice of proposed rulemaking would not have federalism implications.

Environmental Analysis

FAA Order 1050.1D defines FAA actions that may be categorically excluded from preparation of a National Environmental Policy Act (NEPA) environmental impact statement. In accordance with FAA Order 1050.1D, appendix 4, paragraph 4(j), this proposed rulemaking action qualifies for a categorical exclusion.

Energy Impact

The energy impact of the notice has been assessed in accordance with the Energy Policy and Conservation Act (EPCA) Pub. L. 94-163, as amended (42 U.S.C. 6362) and FAA Order 1053.1. It has been determined that the notice is not a major regulatory action under the provisions of the EPCA.

List of Subjects

14 CFR Part 91

Aircraft, Aviation Safety, Reporting and recordkeeping requirements

14 CFR Part 121

Air carriers, Aircraft, Aviation Safety, Reporting and recordkeeping requirements, Safety, Transportation

14 CFR Part 125

Aircraft, Aviation Safety, Reporting and recordkeeping requirements

14 CFR Part 129

Air carriers, Aircraft, Aviation Safety, Reporting and recordkeeping requirements

14 CFR Part 135

Aircraft, Aviation safety, Reporting and recordkeeping requirements

The Proposed Amendment

In consideration of the foregoing, the Federal Aviation Administration proposes to amend parts 91, 121, 125, 129, and 135 of Title 14, Code of Federal Regulations, as follows:

PART 91 - GENERAL OPERATING AND FLIGHT RULES

1. The authority citation for part 91 continues to read:

Authority: *49 U.S.C. 106(g), 40103, 40113, 40120, 44101, 44111, 44701, 44709, 44711, 44712, 44715, 44716, 44717, 44722, 46306, 46315, 46316, 46502, 46504, 46506-46507, 47122, 47508, 47528-47531.*

2. Add § 91.4XX as follows:

§ 91.4XX Basis of Structural Maintenance Program.

No person may operate a transport category airplane, greater than 75,000 pounds (maximum takeoff gross weight), beyond [one year after the effective date of the amendment], unless Instructions for Continued Airworthiness (ICA), developed in accordance with Appendix H of part 25, are incorporated within its inspection program. The ICA must contain a section titled Airworthiness Limitations (ALS) that is segregated and clearly distinguishable from the rest of the document. The ALS must be approved by the FAA Aircraft Certification Office (ACO), or office of the Transport Airplane Directorate (TAD), having cognizance over the type certificate for the affected airplane. The ALS must contain either (a) or (b):

(a) For each airplane that has a certification basis that does include a requirement for damage-tolerance based inspections and procedures, this section must set forth each mandatory replacement time, structural inspection interval and related structural inspection procedure approved under § 25.571, which includes a structural maintenance program that includes a corrosion prevention and control program, repair assessment program and a mandatory modifications program and with a stated limit of validity in flight cycles or flight hours.

(b) For each airplane that has a certification basis that does not include a requirement for damage-tolerance based inspections and procedures, this section must include the supplemental structural inspection program, corrosion prevention and control program, repair assessment program and mandatory modifications program and include a structural maintenance program with a stated limit of validity in flight cycles or flight hours.

3. Add § 91.4YY as follows:

§ 91.4YY Aging Aircraft Program (Widespread Fatigue Damage).

(a) No person may operate a transport category airplane, greater than 75,000 pounds (maximum takeoff gross weight), beyond the flight cycle limits shown in its Airworthiness Limitations section (ALS) of the Instructions for Continued Airworthiness (ICA), or [a date one year after the effective date of the amendment], whichever occurs later, unless a structural maintenance program is incorporated within its inspection program. This new program must include inspections and modification/replacement actions to the baseline structure for prevention of WFD. The baseline structure is defined as that airplane structure that was originally built by the TCH. The new structural maintenance program will be limited by flight cycles or flight hours, which must be specified in the ALS of the ICA that has been approved by the FAA Aircraft Certification Office (ACO) or office of the Transport Airplane Directorate (TAD), having cognizance over the type certificate for the affected airplane. Any subsequent changes to the structural maintenance program must also be approved by the FAA ACO or office of the TAD, having cognizance over the type certificate for the affected airplane before they can be incorporated within the operator's inspection program.

(b) No person may operate a transport category airplane, greater than 75,000 pounds (maximum takeoff gross weight), 48 months after initial incorporation per paragraph (a), or 48 months beyond the time that the airplane has accumulated the flight cycles or flight hours shown in the limit of validity manifested in its Airworthiness Limitations section (ALS) of the Instructions for Continued Airworthiness (ICA), whichever occurs later, unless a structural maintenance program is incorporated within its inspection program. This new program must include inspections and modification/replacement actions to repairs, alterations or modifications susceptible to MSD or MED or repairs, alterations or modifications that affect the baseline structure that is susceptible to MSD or MED accomplished prior to the effective date of this proposed rule, for prevention of WFD. The new structural maintenance program must be approved by the FAA ACO or office of the TAD, having cognizance over the type certificate for the affected airplane. The following requirements are to be accomplished at the times noted below:

(1) Within six months after initial incorporation per paragraph (a) or within six months beyond the time that the airplane has accumulated the flight cycles or flight hours shown in the limit of validity manifested in its ALS of the ICA, whichever occurs later, each operator establishes a plan to address repairs, alterations and modifications, which includes identification of interim inspections of applicable repairs, alterations and modifications. Each operator submits that plan to the FAA ACO or office of the TAD through the operator's PMI.

(2) Within six months after receipt of the plan, the FAA ACO or office of the TAD approves the plan if it is acceptable.

(3) Within six months after receipt of the FAA approved plan, each operator incorporates interim inspections of applicable repairs, alterations, and modifications identified in the plan.

(4) Within 36 months after initial incorporation per paragraph (a) or within 36 months beyond the time that the airplane has accumulated the flight cycles or flight hours shown in the limit of validity manifested in its ALS of the ICA, whichever occurs later, each operator submits a structural maintenance program to the FAA ACO or office of the TAD through the operator's PMI.

(5) Within six months after receipt of the structural maintenance program, the FAA ACO or office of the TAD approves the program if it is acceptable.

(6) Within 48 months after initial incorporation per paragraph (a) or within 48 months beyond the time that the airplane has accumulated the flight cycles or flight hours shown in the limit of validity manifested in its ALS of the ICA, whichever occurs later, each operator incorporates the FAA approved structural maintenance program into its maintenance or inspection program.

(c) No person may operate a transport category airplane, greater than 75,000 pounds (maximum takeoff gross weight), 18 months after a repair, alteration or modification susceptible to MSD or MED or a repair, alteration or modification that affects the baseline structure that is susceptible to MSD or MED is accomplished on or after the effective date of the rule, unless a structural maintenance program is incorporated within its inspection program. This new program must include a threshold where inspections and/or modification/replacement actions to said repair, alteration, or modification must be incorporated to preclude WFD. The new structural maintenance program must be approved by the FAA ACO or office of the TAD, having cognizance over the type certificate for the affected airplane. The following requirements are to be accomplished at the times noted below:

(1) The static strength approval of the repair, alteration, or modification is to be accomplished before further flight.

(2) Within 18 months of the static strength approval, a damage tolerance analysis that includes a WFD analysis of the repair, alteration or modification is approved by the FAA ACO or office of the TAD, which defines the threshold for inspections and/or modification/replacement actions.

(3) Within 24 months before reaching the threshold, specific FAA approved inspection methods and repeat intervals are incorporated for each repair, alteration or modification into the FAA approved structural maintenance program.

PART 121 - CERTIFICATION AND OPERATIONS: DOMESTIC, FLAG, AND SUPPLEMENTAL AIR CARRIERS AND COMMERCIAL OPERATORS OF LARGE AIRCRAFT.

4. The authority citation for part 121 continues to read:

***Authority:** 49 U.S.C. 106(g), 40113, 40119, 44101, 44701-44702, 44705, 44709-44711, 44713, 44716-44717, 44722, 44901, 44903-44904, 44912, 46105.*

5. Add § 121.3XX as follows:

§ 121.3XX Basis of Structural Maintenance Program.

No certificate holder may operate a transport category airplane, greater than 75,000 pounds (maximum takeoff gross weight), beyond [one year after the effective date of the amendment], unless Instructions for Continued Airworthiness (ICA), developed in accordance with Appendix H of part 25, are incorporated within its maintenance program. The ICA must contain a section title Airworthiness Limitations (ALS) that is segregated and clearly distinguishable from the rest of the document. The ALS must be approved by the FAA Aircraft Certification Office (ACO), or office of the Transport Airplane Directorate (TAD), having cognizance over the type certificate for the affected airplane. The ALS must contain either (a) or (b):

(a) For each airplane that has a certification basis that does include a requirement for damage-tolerance based inspections and procedures, this section must set forth each mandatory replacement time, structural inspection interval and related structural inspection procedure approved under § 25.571, which includes a structural maintenance program that includes a corrosion prevention and control program, repair assessment program and mandatory modifications program and with a stated limit of validity in flight cycles or flight hours.

(b) For each airplane that has a certification basis that does not include a requirement for damage-tolerance based inspections and procedures, this section must include the supplemental structural inspection program, corrosion prevention and control program, repair assessment program and mandatory modifications program and include a structural maintenance program with a stated limit of validity in flight cycles or flight hours.

6. Add § 121.3YY as follows:

§ 121.3YY Aging Aircraft Program (Widespread Fatigue Damage).

(a) No certificate holder may operate a transport category airplane, greater than 75,000 pounds (maximum takeoff gross weight), beyond the flight cycle limits shown in its Airworthiness Limitations section (ALS) of the Instructions for Continued Airworthiness (ICA), or [a date one year after the effective date of the amendment], whichever occurs later, unless a structural maintenance program is incorporated within its maintenance program. This new program must include inspections and modification/replacement actions to the baseline structure for prevention of WFD. The baseline structure is defined as that airplane structure that was originally built by the TCH. The new structural maintenance program will be limited by flight cycles or flight hours, which must be specified in the ALS of the ICA that has been approved by the FAA Aircraft Certification Office (ACO) or office of the Transport Airplane Directorate (TAD), having cognizance over the type certificate for the affected airplane. Any subsequent changes to the structural maintenance program must also be approved by the FAA ACO or office of the TAD, having cognizance over the type certificate for the affected airplane before they can be incorporated within the operator's maintenance program.

(b) No certificate holder may operate a transport category airplane, greater than 75,000 pounds (maximum takeoff gross weight), 48 months after initial incorporation per paragraph (a), or 48 months beyond the time that the airplane has accumulated the flight cycles flight hours shown in the limit of validity manifested in its Airworthiness Limitations section (ALS) of the Instructions for Continued Airworthiness (ICA), whichever occurs later, unless a structural maintenance program is incorporated within its maintenance program. This new program must include inspections and modification/replacement actions to repairs, alterations or modifications to susceptible to MSD or MED or repairs, alterations or modifications that affect the baseline structure that is susceptible to MSD or MED accomplished prior to the effective date of this proposed rule, for prevention of WFD. The new structural

maintenance program must be approved by the FAA ACO or office of the TAD, having cognizance over the type certificate for the affected airplane. The following requirements are to be accomplished at the times noted below:

(1) Within six months after initial incorporation per paragraph (a) or within six months beyond the time that the airplane has accumulated the flight cycles or flight hours shown in the limit of validity manifested in its ALS of the ICA, whichever occurs later, each operator establishes a plan to address repairs, alterations and modifications, which includes identification of interim inspections of applicable repairs, alterations and modifications. Each operator submits that plan to the FAA ACO or office of the TAD through the operator's PMI.

(2) Within six months after receipt of the plan, the FAA ACO or office of the TAD approves the plan if it is acceptable.

(3) Within six months after receipt of the FAA approved plan, each operator incorporates interim inspections of applicable repairs, alterations, and modifications identified in the plan.

(4) Within 36 months after initial incorporation per paragraph (a) or within 36 months beyond the time that the airplane has accumulated the flight cycles or flight hours shown in the limit of validity manifested in its ALS of the ICA, whichever occurs later, each operator submits the structural maintenance program to the FAA ACO or office of the TAD through the operator's PMI.

(5) Within six months after receipt of the structural maintenance program, the FAA ACO or office of the TAD approves the program if it is acceptable.

(6) Within 48 months after initial incorporation per paragraph (a) or within 48 months beyond the time that the airplane has accumulated the flight cycles or flight hours shown in the limit of validity manifested in its ALS of the ICA, whichever occurs later, each operator incorporates the FAA approved program into its maintenance program.

(c) No certificate holder may operate a transport category airplane, greater than 75,000 pounds (maximum takeoff gross weight), 18 months after a repair, alteration or modification susceptible to MSD or MED or a repair, alteration or modification that affects baseline structure that is susceptible to MSD or MED is accomplished on or after the effective date of the rule, unless a structural maintenance program is incorporated within its maintenance program. This new program must include a threshold where inspections and modification/replacement actions to said repair, alteration, or modification must be incorporated to preclude WFD. The new structural maintenance program must be approved by the FAA ACO or office of the TAD, having cognizance over the type certificate for the affected airplane. The following requirements are to be accomplished at the times noted below:

(1) The static strength approval of the repair, alteration, or modification is to be accomplished before further flight.

(2) Within 18 months of the static strength approval, a damage-tolerance analysis that includes a WFD analysis of the repair, alteration or modification is approved by the FAA ACO or office of the TAD, which defines the threshold for inspections and/or modification/replacement actions.

(3) Within 24 months before reaching the threshold, specific FAA approved inspection methods and repeat intervals are incorporated for each repair, alteration or modification into the FAA approved structural maintenance program.

PART 125 - CERTIFICATION AND OPERATIONS: AIRPLANES HAVING A SEATING CAPACITY OF 20 OR MORE PASSENGERS OR A MAXIMUM PAYLOAD CAPACITY OF 6,000 POUNDS OR MORE

7. The authority citation for part 125 continues to read:

***Authority:** 49 U.S.C. 106(g), 40113, 44701-44702, 44705, 44710-44711, 44713, 44716-44717, 44722.*

8. Add § 125.2XX as follows:

§ 125.2XX Basis of Structural Maintenance Program.

No person may operate a transport category airplane, greater than 75,000 pounds (maximum takeoff gross weight), beyond [one year after the effective date of the amendment], unless Instructions for Continued Airworthiness (ICA), developed in accordance with Appendix H of part 25, are incorporated within its maintenance program. The ICA must contain a section titled Airworthiness Limitations (ALS) that is segregated and clearly distinguishable from the rest of the document. The ALS must be approved by the FAA Aircraft Certification Office (ACO), or office of the Transport Airplane Directorate (TAD), having cognizance over the type certificate for the affected airplane. The ALS must contain either (a) or (b):

(a) For each airplane that has a certification basis that does include a requirement for damage-tolerance based inspections and procedures, this section must set forth each mandatory replacement time, structural inspection interval and related structural inspection procedure approved under § 25.571, which includes a structural maintenance program that includes a corrosion prevention and control program, repair assessment program and mandatory modifications program and with a stated limit of validity in flight cycles or flight hours.

(b) For each airplane that has a certification basis that does not include a requirement for damage-tolerance based inspections and procedures, this section must include the supplemental structural inspection program, corrosion prevention and control program, repair assessment program and mandatory modifications program with a stated limit of validity in flight cycles or flight hours.

9. Add § 125.2YY as follows:

§ 125.2YY Aging Aircraft Program (Widespread Fatigue Damage).

(a) No person may operate a transport category airplane, greater than 75,000 pounds (maximum takeoff gross weight), beyond the flight cycle limits shown in its Airworthiness Limitations section (ALS) of the Instructions for Continued Airworthiness (ICA), or [a date one year after the effective date of the amendment], whichever occurs later, unless a structural maintenance program is incorporated within its maintenance program. This new program must include inspections and modification/replacement actions to the baseline structure for prevention of WFD. The baseline structure is defined as that airplane structure that was originally built by the TCH. The new structural maintenance program will be limited by flight cycles or flight hours, which must be specified in the ALS of the ICA that has been approved by the FAA Aircraft Certification Office (ACO) or office of the Transport Airplane Directorate (TAD), having cognizance over the type certificate for the affected airplane. Any subsequent changes to the structural maintenance program must also be approved by the FAA ACO or office of the TAD, having cognizance over the type certificate for the affected airplane before they can be incorporated within the operator's maintenance program.

(b) No person may operate a transport category airplane, greater than 75,000 pounds (maximum takeoff gross weight), 48 months after initial incorporation per paragraph (a), or 48 months beyond the time that the airplane has accumulated the flight cycles or flight hours shown in the limit of validity manifested in its Airworthiness Limitations section (ALS) of the Instructions for Continued Airworthiness (ICA), whichever occurs later, unless a structural maintenance program is incorporated within its maintenance program. This new program must include inspections and modification/replacement actions to repairs, alterations or modifications susceptible to MSD or MED or repairs, alterations or modifications that affect baseline structure that is susceptible to MSD or MED accomplished prior to the effective date of this proposed rule, for prevention of WFD. The new structural maintenance program must be approved by the FAA ACO or office of the TAD, having cognizance over the type certificate for the affected airplane. The following requirements are to be accomplished at the times noted below:

(1) Within six months after initial incorporation per paragraph (a) or within six months beyond the time that the airplane has accumulated the flight cycles or flight hours shown in the limit of validity manifested in its ALS of the ICA, whichever occurs later, each operator establishes a plan to address repairs, alterations and modifications, which includes identification of interim inspections of applicable

repairs, alterations and modifications. Each operator submits that plan to the FAA ACO or office of the TAD through the operator's PMI.

(2) Within six months after receipt of the plan, the FAA ACO or office of the TAD approves the plan if it is acceptable.

(3) Within six months after receipt of the FAA approved plan, each operator incorporates interim inspections of applicable repairs, alterations, and modifications identified in the plan.

(4) Within 36 months after initial incorporation per paragraph (a) or within 36 months beyond the time that the airplane has accumulated the flight cycles or flight hours shown in the limit of validity manifested in its ALS of the ICA, whichever occurs later, each operator submits a structural maintenance program to the FAA ACO or office of the TAD through the operator's PMI.

(5) Within six months after receipt of the structural maintenance program, the FAA ACO or office of the TAD approves the program if it is acceptable.

(6) Within 48 months after initial incorporation per paragraph (a) or within 48 months beyond the time that the airplane has accumulated the flight cycles or flight hours shown in the limit of validity manifested in its ALS of the ICA, whichever occurs later, each operator incorporates the FAA approved structural maintenance program into its maintenance program.

(c) No person may operate a transport category airplane, greater than 75,000 pounds (maximum takeoff gross weight), 18 months after a repair, alteration or modification susceptible to MSD or MED or a repair, alteration or modification that affects the baseline structure that is susceptible to MSD or MED is accomplished on or after the effective date of the rule, unless a structural maintenance program is incorporated within its maintenance program. This new program must include a threshold where inspections and/or modification/replacement actions to said repair, alteration, or modification must be incorporated to preclude WFD. The new structural maintenance program must be approved by the FAA ACO or office of the TAD, having cognizance over the type certificate for the affected airplane. The following requirements are to be accomplished at the times noted below:

(1) The static strength approval of the repair, alteration, or modification is to be accomplished before further flight.

(2) Within 18 months of the static strength approval, a DTA analysis that includes a WFD analysis of the repair, alteration or modification is approved by the FAA ACO or office of the TAD, which defines the threshold for inspections and/or modification/replacement actions.

(3) Within 24 months before reaching the threshold, specific FAA approved inspection methods and repeat intervals are incorporated for each repair. Alteration or modification into the FAA approved structural maintenance program.

PART 129 - OPERATIONS: FOREIGN AIR CARRIERS AND FOREIGN OPERATORS OF U.S.-REGISTERED AIRCRAFT ENGAGED IN COMMON CARRIAGE

10. The authority citation for part 129 continues to read:

***Authority:** 49 U.S.C. 106(g), 40104-40105, 40113, 40119, 44701-44702, 44712, 44716-44717, 44722, 44901-44904, 44906.*

11. Add § 129.3X as follows:

§ 129.3X Basis of Structural Maintenance Program.

No foreign air carrier or foreign persons operating a U.S. registered airplane may operate a transport category airplane, greater than 75,000 pounds (maximum takeoff gross weight), beyond [one year after the effective date of the amendment], unless Instructions for Continued Airworthiness (ICA), developed in accordance with Appendix H of part 25, are incorporated within its maintenance program. The ICA must contain a section titled Airworthiness Limitations (ALS) that is segregated and clearly distinguishable from the rest of the document. The ALS must be approved by the FAA Aircraft

Certification Office (ACO), or office of the Transport Airplane Directorate (TAD), having cognizance over the type certificate for the affected airplane. The ALS must contain either (a) or (b):

(a) For each airplane that has a certification basis that does include a requirement for damage-tolerance based inspections and procedures, this section must set forth each mandatory replacement time, structural inspection interval and related structural inspection procedure approved under § 25.571, which includes a structural maintenance program that includes a corrosion prevention and control program, repair assessment program and mandatory modifications program and with a stated limit of validity in flight cycles or flight hours.

(b) For each airplane that has a certification basis that does not include a requirement for damage tolerance based inspections and procedures, this section must include the supplemental structural inspection program, corrosion prevention and control program, repair assessment program and mandatory modifications program with a stated limit of validity in flight cycles or flight hours.

12. Add § 129.3Y as follows:

§ 129.3Y Aging Aircraft Program (Widespread Fatigue Damage)

(a) No foreign air carrier or foreign persons operating a U.S. registered airplane may operate a transport category airplane, greater than 75,000 pounds (maximum takeoff gross weight), beyond the flight cycle limits shown in its Airworthiness Limitations section (ALS) of the Instructions for Continued Airworthiness (ICA), or [a date one year after the effective date of the amendment], whichever occurs later, unless a structural maintenance program is incorporated within its maintenance program. This new program must include inspections and modification/replacement actions to the baseline structure for prevention of WFD. The baseline structure is defined as that airplane structure that was originally built by the TCH. The new structural maintenance program will be limited by flight cycles or flight hours, which must be specified in the ALS of the ICA that has been approved by the FAA Aircraft Certification Office (ACO) or office of the Transport Airplane Directorate (TAD), having cognizance over the type certificate for the affected airplane. Any subsequent changes to the structural maintenance program must also be approved by the FAA ACO or office of the TAD, having cognizance over the type certificate for the affected airplane before they can be incorporated within the operator's maintenance program.

(b) No foreign air carrier or foreign persons operating a U.S. registered airplane may operate a transport category airplane, greater than 75,000 pounds (maximum takeoff gross weight), 48 months after initial incorporation per paragraph (a), or 48 months beyond the time that the airplane has accumulated the flight cycles or flight hours shown in the limit of validity manifested in its Airworthiness Limitations section (ALS) of the Instructions for Continued Airworthiness (ICA), whichever occurs later, unless a structural maintenance program is incorporated within its maintenance program. This new program must include inspections and modification/replacement actions to repairs, alterations or modifications susceptible to MSD or MED or repairs, alterations or modifications that affect baseline structure that is susceptible to MSD or MED accomplished prior to the effective date of this proposed rule, for prevention of WFD. The new structural maintenance program must be approved by the FAA ACO or office of the TAD, having cognizance over the type certificate for the affected airplane. The following requirements are to be accomplished at the times noted below:

(1) Within six months after initial incorporation per paragraph (a) or within six months beyond the time that the airplane has accumulated the flight cycles or flight hours shown in the limit of validity manifested in its ALS of the ICA, whichever occurs later, each operator establishes a plan to address repairs, alterations and modifications, which includes identification of interim inspections of applicable repairs, alterations and modifications. Each operator submits that plan to the FAA ACO or office of the TAD through the operator's PMI.

(2) Within six months after receipt of the plan, the FAA ACO or office of the TAD approves the plan if it is acceptable.

(3) Within six months after receipt of the FAA approved plan, each operator incorporate interim inspections of applicable repairs, alterations and modifications identified in the plan.

(4) Within 36 months after initial incorporation per paragraph (a) or within 36 months beyond the time that the airplane has accumulated the flight cycles or flight hours shown in the limit of validity manifested in its ALS of the ICA, whichever occurs later, each operator submits the structural maintenance program to the FAA ACO or office of the TAD through the operator's PMI.

(5) Within six months after receipt of the structural maintenance program, the FAA ACO or office of the TAD approves the program if it is acceptable.

(6) Within 48 months after initial incorporation per paragraph (a) or within 48 months beyond the time that the airplane has accumulated the flight cycles or flight hours shown in the limit of validity manifested in its ALS of the ICA, whichever occurs later, each operator incorporates the FAA approved structural maintenance program into its maintenance program.

(c) No foreign air carrier or foreign persons operating a U.S. registered airplane may operate a transport category airplane, greater than 75,000 pounds (maximum takeoff gross weight), 18 months after a repair, alteration or modification susceptible to MSD or MED or a repair, alteration or modification that affects baseline structure that is susceptible to MSD or MED is accomplished on or after the effective date of the rule, unless a structural maintenance program is incorporated within its maintenance program. This new program must include a threshold where inspections and/or modification/replacement actions to said repair, alteration, or modification must be incorporated to preclude WFD. The new structural maintenance program must be approved by the FAA ACO or office of the TAD, having cognizance over the type certificate for the affected airplane. The following requirements are to be accomplished at the times noted below:

(1) The static strength approval of the repair, alteration, or modification is to be accomplished before further flight.

(2) Within 18 months of the static strength approval, a damage-tolerance analysis that includes a WFD analysis of the repair, alteration or modification is approved by the FAA ACO or office of the TAD, which defines the threshold for inspections and/or modification/replacement actions.

(6) Within 24 months before reaching the threshold, specific FAA approved inspection methods and repeat intervals are incorporated for each repair, alteration or modification into the FAA approved structural maintenance program.

PART 135 – OPERATING REQUIREMENTS: COMMUTER AND ON-DEMAND OPERATIONS.

13. The authority citation for part 135 continues to read:

***Authority:** 49 U.S.C. 106(g), 44113, 44701-44702, 44705, 44709, 44711-44713, 44715-44717, 44722.*

14. Add § 135.4XX as follows:

§ 135.4XX Basis of Structural Maintenance Program.

No certificate holder may operate a transport category airplane, greater than 75,000 pounds (maximum takeoff gross weight), beyond [one year after the effective date of the amendment], unless Instructions for Continued Airworthiness (ICA), developed in accordance with Appendix H of part 25, are incorporated within its maintenance program. The ICA must contain a section titled Airworthiness Limitations (ALS) that is segregated and clearly distinguishable from the rest of the document. The ALS must be approved by the FAA Aircraft Certification Office (ACO, or office of the Transport Airplane Directorate (TAD), having cognizance over the type certificate for the affected airplane. The ALS must contain either (a) or (b):

(a) For each airplane that has a certification basis that does include a requirement for damage-tolerance based inspections and procedures, this section must set forth each mandatory replacement time, structural inspection interval and related structural inspection procedure approved under § 25.571, which includes a structural maintenance program that includes a corrosion prevention and control program, repair assessment program, and mandatory modifications program and with a stated limit of validity in flight cycles or flight hours.

(b) For each airplane that has a certification basis that does not include a requirement for damage-tolerance based inspections and procedures, this section must include the supplemental structural inspection program, corrosion prevention and control program, repair assessment program and mandatory modifications program with a stated limit of validity in flight cycles or flight hours.

15. Add § 135.4YY as follows:

§ 135.4YY Aging Aircraft Program (Widespread Fatigue Damage).

(a) No certificate holder may operate a transport category airplane, greater than 75,000 pounds (maximum takeoff gross weight), beyond the flight cycle limits shown in its Airworthiness Limitations section (ALS) of the Instructions for Continued Airworthiness (ICA), or [a date one year after the effective date of the amendment], whichever occurs later, unless a structural maintenance program is incorporated within its inspection program. This new program must include inspections and modification/replacement actions to the baseline structure for prevention of WFD. The baseline structure is defined as that airplane structure that was originally built by the TCH. The new structural maintenance program will be limited by flight cycles or flight hours, which must be specified in the ALS of the ICA that has been approved by the FAA Aircraft Certification Office (ACO) or office of the Transport Airplane Directorate (TAD), having cognizance over the type certificate for the affected airplane. Any subsequent changes to the structural maintenance program must also be approved by the FAA ACO or office of the TAD, having cognizance over the type certificate for the affected airplane before they can be incorporated within the operator's maintenance program.

(b) No certificate holder may operate a transport category airplane, greater than 75,000 pounds (maximum takeoff gross weight), 48 months after initial incorporation per paragraph (a) or 48 months beyond the time that the airplane has accumulated the flight cycles or flight hours shown in the limit of validity manifested in its Airworthiness Limitations section (ALS) of the Instructions for Continued Airworthiness (ICA), whichever occurs later, unless a structural maintenance program is incorporated within its maintenance program. This new program must include inspections and modification/replacement actions to repairs, alterations or modifications susceptible to MSD or MED or repairs, alterations or modifications that affect the baseline structure that is susceptible to MSD or MED accomplished prior to the effective date of this proposed rule, for prevention of WFD. The new structural maintenance program must be approved by the FAA ACO or office of the TAD, having cognizance over the type certificate for the affected airplane. The following requirements are to be accomplished at the times noted below:

(1) Within six months after initial incorporation per paragraph (a) or within six months beyond the time that the airplane has accumulated the flight cycles or flight hours shown in the limit of validity manifested in its ALS of the ICA, whichever occurs later, each operator establishes a plan to address repairs, alterations and modifications, which includes identification of interim inspections of applicable repairs, alterations and modifications. Each operator submits that plan to the FAA ACO or office of the TAD through the operator's PMI.

(2) Within six months after receipt of the plan, the FAA ACO or office of the TAD approves the plan if it is acceptable.

(3) Within six months after receipt of the FAA approved plan, each operator incorporates interim inspections of applicable repairs, alterations, and modifications identified in the plan.

(4) Within 36 months after initial incorporation per paragraph (a) or within 36 months beyond the time that the airplane has accumulated the flight cycles or flight hours shown in the limit of validity manifested in its ALS of the ICA, whichever occurs later, each operator submits the structural maintenance program to the FAA ACO or office of the TAD through the operator's PMI.

(5) Within six months after receipt of the structural maintenance program, the FAA ACO or office of the TAD approves the program if it is acceptable.

(6) Within 48 months after initial incorporation per paragraph (a) or within 48 months beyond the time that the airplane has accumulated the flight cycles or flight hours shown in the limit of validity

manifested in its ALS of the ICA, whichever occurs later, each operator incorporates the FAA approved structural maintenance program into its maintenance program.

(c) No certificate holder may operate a transport category airplane, greater than 75,000 pounds (maximum takeoff gross weight), 18 months after a repair, alteration or modification susceptible to MSD or MED or a repair, alteration or modification that affects baseline structure that is susceptible to MSD or MED is accomplished on or after the effective date of the rule, unless a structural maintenance program is incorporated within its maintenance program. This new program must include a threshold where inspections and/or modification/replacement actions to said repair, alteration, or modification must be incorporated to preclude WFD. The new structural maintenance program must be approved by the FAA ACO or office of the TAD, having cognizance over the type certificate for the affected airplane. The following requirements are to be accomplished at the times noted below:

(1) The static strength approval of the repair, alteration, or modification is to be accomplished before further flight.

(2) Within 18 months of the static strength approval, a damage-tolerance analysis that includes a WFD analysis of the repair, alteration or modification is approved by the FAA ACO or office of the TAD, which defines the threshold for inspections and/or modification/replacement actions.

(3) Prior to 24 months before reaching the threshold, specific FAA approved inspection methods and repeat intervals are incorporated for each repair, alteration or modification into the FAA approved structural maintenance program.

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Appendix E: AAWG Recommendations to TAEIG Concerning Proposed Follow-on Task 2, 3 and 4 Activities

The following is a proposal for the follow activities that were defined in the report.

Background:

In the Federal Register / Vol. 69, No. 93 / Thursday, May 13, 2004 / Notices Aviation Rulemaking Advisory Committee; Transport Airplane and Engine Issues—New Task, Page 26641, The FAA assigned ARAC a new task to develop guidance that will support industry compliance with the Aging Airplane Safety Final Rule requirements that relate to supplemental structural inspections. ARAC assigned this tasking to the Airworthiness Assurance Working Group (AAWG). In Task 2 and 3 of the subject tasking, the AAWG was to write a report to include a proposed action plan for addressing recommendations from Tasks 2 and 3 (the best means to incorporate damage tolerance based inspections and procedures for alterations and modifications and developing widespread fatigue damage maintenance requirements for repairs, alterations and modifications). The report was to include a proposed action plan to address or accomplish these recommendations. This action plan would be submitted to the TAEIG who would determine, as appropriate, the means by which the action plan be implemented. In addition, the AAWG will support the implementation of the action plan to address recommendations made in Tasks 2 and 3 as determined necessary by the ARAC, Transport Airplane and Engine Issues Group, and concurred with by the FAA. The AAWG is also responsible for the oversight of the STG activities for development of the compliance data according to AC 120-AAWG as amended by any follow-on guidance material from this Tasking.

Task 4 is a combination of follow-on activities from Task 2 and 3 combined with the specific Task 4 activities.

Task 2 Proposed Action Plan for Follow-on Activities– Damage Tolerance Based Inspections And Procedures For Alterations And Modifications.

The AAWG determined that additional specific guidance material was necessary for the industry to uniformly develop DT data for previously installed Alterations and Modifications. Specifics of that recommendation are included in Section 3 of this report. The AAWG requests that the TAEIG task the following to the AAWG:

1. The AAWG will prepare and submit guidance materials for consideration of alterations and modifications to the TAEIG within six months of TAEIG acceptance of the written report.
2. Upon TAEIG acceptance of the AAWG guidance material, the AAWG will recommend that Model Specific STGs invite STC DAH and involve them in the dialog to ensure that DT data is in existence on December 18, 2009 for all commonly embodied STCs in concert with Task 4 of the original tasking.

Task 3 Proposed Action Plan – Widespread Fatigue Damage of Repairs Alterations and Modifications

The AAWG determined that additional specific guidance material was necessary for the industry to uniformly develop WFD data for previously installed Repairs, Alterations and Modifications. Specifics of that recommendation are included in Section 4 of this report. The AAWG requests that the TAEIG task the following to the AAWG:

The AAWG will develop and provide additional guidance data for the development of WFD data for repairs and provide it to ARAC within 6 months of TAEIG acceptance of this proposal. The AAWG will then establish a group of technical experts that will develop the required technical basis for the guidance material. They will then develop that material for inclusion in either FAA Advisory Circular 120-AAWG or another yet to be determined AC. This guidance material should include:

1. Screening process to identify significant repairs, alterations, and modifications. The guidance material should contain a means to screen repairs, alterations, and modifications to determine which ones would be of a potential concern for development of WFD.
2. Invitation to significant STC holders to participate in the STG. An invitation should be extended to those DAHs who hold the certification data for repairs, alterations, and modifications identified in step one. Their participation in the STG will be of great assistance in developing the required data.
3. Developing means to acquire data for significant repairs, alterations, and modifications where the DAHs are not in a position to supply the data. There will be some repairs, alterations, and modifications where the DAH is unavailable to develop the data. The STG should develop a plan whereby the data is developed.
4. There may be other actions that could be considered to assist the operators in developing the data.

TASK 4 PROPOSED ACTION PLAN – MODEL SPECIFIC PROGRAMS

The following actions will be taken by the AAWG upon acceptance of the findings of this report by TAEIG.

1. The AAWG will list the STGs currently in existence and will identify those airplane models that do not have an STG

2. Assess the need to form an STG on a model specific basis (based on industry benefit).

3. For those airplane models that will need to form an STG, the AAWG will initiate the coordination required to form the STG with the respective type certificate holder and/or part 121 and 129 certificate holders.

4. The AAWG will support the implementation of the action plan to address recommendations made in tasks 2 and 3 as determined necessary by the ARAC, Transport Airplane and Engine Issues Group, and concurred with by the FAA.

Schedule

All recommendations for additional guidance material under Task 2 and 3 must be complete and submitted to ARAC no later than six months after TAEIG Acceptance of the findings in this report.

The Structures Task Groups, under the direction of the ARAC, should produce the model specific guidance material, Task 4, using the guidelines and procedures of the AC produced in Phase 1. The ARAC will be responsible for coordinating and overseeing the STG's application of the AC. Phase 2 documents should be completed by December 18, 2009.

Working Group Activity

The Airworthiness Assurance Working Group must comply with the procedures adopted by ARAC. This normally requires the following elements:

1. Recommend a work plan for completion of the task, including the rationale supporting such a plan for consideration at the next meeting of the ARAC on transport airplane and engine issues held following publication of this notice.

2. Give a detailed conceptual presentation of the proposed recommendations prior to proceeding with the work stated in item 3 below.

3. Draft the appropriate documents and required analyses and/or any other related materials or documents.

4. Provide a status report at each meeting of the ARAC held to consider transport airplane and engine issues.

Whereas this is an oversight activity, items 1, 2 and 3 will not be required. However status reports on the progress of the STGs in developing compliance documents and data will be required at each meeting of the ARAC held to consider transport airplane and engine issues.

Appendix F: AAWG Meetings and Attendance Records

1. Meeting Dates and Venues

AAWG Meetings

July 23, 2003	--	Atlanta Georgia (Delta Air Lines)
June 30, 2004	--	Long Beach CA (FAA)
March 1, 2005	--	Miami FL (Airbus)
October 26, 2005	--	Memphis TN (FedEx)

Task Group Meetings

Ad-hoc Task Planning Group		
September 15-17, 2003	–	Seattle Washington (Boeing)
November 11-14, 2003	–	London England (British Airways)
March 29-April 2, 2004	–	Toulouse France (Airbus)
May 17-21, 2004	–	Memphis Tennessee (FedEx)
Task Group Meetings		
July 12-16, 2004	–	Gatwick England (CAA-UK)
September 20-21, 2004	–	Long Beach (Boeing)
November 15-19, 2004	–	Brussels Belgium (FAA)
January 31- Feb 4, 2005	–	Miami FL (Airbus)
March 14-18, 2005	–	Hamburg GE (Airbus)
May 2-6, 2005	–	Long Beach CA (FAA/Boeing)
June 13-19, 2005	–	Collioure FR (Airbus)
September 26-30, 2005	–	Seattle WA (Boeing)

2. AAWG Organizational Meeting Attendance

	MEETING DATE			
Organization	**July 2003**	**June 2004**	**March 2005**	**October 2005**
Airborne Express (M)	X	X	X	X
Airbus (M)	X	X	X	X
ALPA				
America West				
American Airlines (M)	X	X		X
ATA (M)				X
Boeing (M)	X	X	X	X
British Aerospace (M)	X			
British Airways (M)	X	X		X
CAA-UK(JAA) (M)	X			
Continental Airlines (M)	X	X	X	X
Delta Air Lines (M)	X	X		
Evergreen Aviation				
FAA (M)	X	X	X	X
Federal Express (M)	X	X	X	X
Fokker Services				
IATA				
Japan Air Lines		X		
Lockheed (M)	X			
Northwest Airlines (M)		X	X	X
SIE		X		
TIMCO		X		
United Airlines (M)	X	X	X	
UPS (M)	X	X	X	X
US Airways (M)	X	X		X

(M) – AAWG Voting Member

3. AAWG Task Planning Group Organizational Attendance

	MEETING DATES			
Organization	**Sep 2003**	**Nov 2003**	**Mar 2004**	**May 2004**
Airborne Express	X	X		X
Airbus	X	X	X	X
American Airlines	X	X	X	X
ATA				
Boeing	X	X	X	X
British Airways	X	X	X	X
Continental Air Lines	X	X	X	X
Delta Air Lines	X	X	X	X
EASA		X	X	
FAA	X	X	X	X
Federal Express	X	X		X
Gulfstream		X	X	
Japan Air Lines	X	X	X	X
Lockheed			X	X
Northwest Airlines	X	X	X	X
SIE				
TIMCO				
United Airlines	X			
UPS	X	X		X
US Airways	X	X	X	X

4. AAWG Task Group Organizational Attendance

	MEETING NUMBER							
Organization	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Airborne Express		X		X		X		
Airbus	X	X	X	X	X	X	X	X
American Airlines	X		X	X	X	X	X	
ATA								
Boeing	X	X	X	X	X	X	X	X
British Airways	X	X	X	X	X		X	X
Continental Air Lines								
Delta Air Lines	X	X						
EASA	X	X	X	X				
FAA	X	X	X	X	X	X	X	X
Federal Express	X	X	X	X		X	X	X
Gulfstream								
Japan Air Lines	X	X		X				X
Lockheed								
Northwest Airlines	X	X	X	X	X	X	X	X
SIE						X		
TIMCO								
Transport Canada								X
United Airlines								
UPS	X	X	X	X	X	X	X	X
US Airways	X	X						

No.	Date	Venue
1	July 12-16, 2004	Gatwick England (CAA-UK)
2	September 20-21, 2004	Long Beach (Boeing)
3	November 15-19, 2004	Brussels Belgium (FAA)
4	January 31- Feb 4, 2005	Miami FL (Airbus)
5	March 14-18, 2005	Hamburg GE (Airbus)
6	May 2-6, 2005	Long Beach CA (FAA/Boeing)
7	June 13-19, 2005	Collioure FR (Airbus)
8	September 26-30,2005	Seattle WA (Boeing)

FAA Action – Not Available